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ABSTRACT

The purpose of the conference was to discuss the following issues: (1) curricula relating to the pure and applied sciences of the environment; (2) programs designed to develop the technological skill necessary for the person who deals with some aspect of maintaining a healthful environment; (3) programs designed to develop managers of the environment; and (4) what place the study of living things and their environment should have in every college student's educational experience. The proceedings are divided into 7 sections with each section containing papers pertaining to the subjects under consideration. The sections are: (1) "What Purposes are to be Served by what Kinds of Programs?," including papers dealing with the education and training of the ecologist, environmental scientist, technologist, and manager of the environment, as well as general education in ecology; (2) "Science and Technology: the Question of Emphasis"; (3) "Science and Humanities: Their Interrelationships"; (4) "The Role of Multidisciplinary and Multiuniversity Programs in Today's Multiversity"; (5) the employment environment in the 1970's and 1980's in the public schools, industry, government and public service; (6) reports of the workshops in curriculum development; and (7) the conclusio . (AF)

PROCEEDINGS OF AN INVITATIONAL WORKSHOP ON CURRICULUM DEVELOPMENT IN ECOLOGY AND RELATED ENVIRONMENTAL SCIENCES

December 10-11, 1970
Newporter Inn, Newport Beach

The California State Colleges
Office of the Chancellor
Division of Academic Planning
Los Angeles, California

March, 1971

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FOREWORD

Ecology is the awareness and study of vital interrelationships of man and other living things with their environment. Since it has in the United States, and particularly in California, belatedly become a rather widespread and urgent concern, it has assumed some characteristics of an emotion-charged, idealistic movement, asserting its claims in broadly educational as well as social, economic, and political terms. The purpose of the invitational workshop on ecology and related environmental sciences sponsored by the Office of the Chancellor, and held on December 10-11, 1970 in Newport Beach, was to probe specifically its academic implications, to sort out the connections between a sense of mission for survival and the logic of matters of fact, and to define – insofar as time and commitment allowed – both its requirements and its possibilities within the context of higher education.

We need certainly at this stage of civilization a judicious assessment of college-level provisions for ecological literacy. The development of an informed, enlightened, involved citizenry is a primary task, with its own dimensions and approaches, distinct from specialized degree programs and departmentalization. Far too little is yet done in this regard, but State College general education-breadth requirements could offer a variety of opportunities for emphasis on man and his environment well worth imaginative exploration. The discussions yielded some useful examples and suggestions as to the ecological perceptions that should be part of a common body of knowledge.

Beyond that, pragmatic distinctions are in order between the general education appropriate for college students in the last quarter of the twentieth century and academic-professional programs related to environmental science and management. Within the functions assigned to the California State Colleges, what societal demands, what occupational categories, and what employment prospects derived from environmental problems can realistically be determined? What are the kinds and the numbers of undergraduate and graduate degree majors we should establish to serve society in the 1980's and 90's, and might be expected to sustain even after another cause has superseded the current vogue of bottle-collecting, wildlife-worshipping, and symbolic car-burials? What options should be available to California students?

The workshop participants had obviously a significant opportunity – indeed a challenge and an obligation – to translate ecosystems excitement into educational logic. As they shared their expertise, different viewpoints became of course quickly apparent; an advisory consensus began likewise to emerge, on such matters as the nature and scope of actual and anticipated needs, corresponding curricular routes and instructional strategies, impact on and modification of related existing courses and degree programs, and criteria for determining functional effectiveness. The proceedings of the workshop sessions should therefore prove valuable to interested parties inside and outside the California State College system.

– Gerhard Friedrich
State College Dean,
Academic Planning
California State Colleges

PREFACE

Definition of the scope of this conference was no simple task. The difficulty was not *what* to talk about, but rather *what not* to talk about. The problem was to consider what is, and what could be, the present and future higher education responsibilities in the study and improvement of the environment. The task before us was to select those topics and concerns which were manageable in a short conference and which were of greatest immediate importance to the nineteen California State Colleges. With the help of a most able and energetic planning committee, it was decided that it would be best for the meeting to seek to encompass:

1. curricula relating to the pure and applied sciences of the environment;
2. programs designed to develop the technological skills necessary for the person who deals with some aspect of maintaining a healthful environment;
3. programs designed to develop managers of the environment; and
4. what place the study of living things and their environment should have in every college student's educational experience.

This scope tended to leave for future consideration and campus program development committees the social, economic, and political concerns relating to our environment. This is not to say that they are less important, nor is it to imply that these aspects of higher education programs were not touched upon in the discussions. A major purpose was served in simply bringing representatives from each of the colleges together to exchange ideas. Most of the participants were involved in offering present curricula or in curriculum development concerning ecology and environmental sciences and the study of the environment. It was intended that the discussions would lead to better definitions of the roles the California State Colleges should play, individually and collectively, in the education and training of those who will be dealing with environmental problems in the next twenty years. The pages following demonstrate that this purpose in great measure was well served – though clearly only the first stage of many campus and inter-campus discussions.

In making these proceedings available to interested persons both within and outside the California State College system, it is hoped that a useful dimension in program development will be provided: a complex dimension reflecting the ideas and concepts of a diverse group of individuals sharing a common concern for the environment and engaged in various aspects of education in the preservation of that environment.

The California State Colleges, of course, are not alone in looking for new approaches and perspectives in ecology and environmental sciences. Dartmouth College recently sponsored a conference on undergraduate education in environmental studies.[1] The University of Wisconsin at Green Bay, an institution focused on the environment, is a case study worthy of close attention. The 1970 report of the President's Council on Environmental Quality constitutes a guiding statement upon which college programs may be projected.[2] Samuel Z. Klausner, *On Man in His Environment*, is one of the first books addressed to the general subject of the workshop.[3]

The statements which follow have been edited with an eye toward brevity and preservation of ideas and observations particularly important to curriculum development. Unfortunately the many interesting questions and responses of participants could not be included. The conclusion prepared for these proceedings was not presented at the conference.

– John M. Smart
Office of the Chancellor
California State Colleges

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References:

(1) William A. Reiners and Frank Smallwood, eds., *Undergraduate Education on Environmental Studies* (Hanover, N.H. The Public Affairs Center and Dartmouth Bicentennial Year Committee, April 1970). Individual colleges and universities have engaged in substantial internal studies. See for example, *The Environment and the University of Washington; Report of the President's Advisory Committee in Environmental Studies*, 2 vols. (Seattle, Washington, The University of Washington, June 1970).

(2) Council on Environmental Quality, *Environmental Quality; The First Annual Report of the Council* ... (Washington D.C., United States Government Printing Office, August 1970). See also John S. Steinhart and Stacie Cherniack, *The Universities and Environmental Quality; Commitment to Problem Focused Education* (Washington D.C. Executive Office of the President, Office of Science and Technology, September 1969).

(3) Samuel Z. Klausner, *On Man in His Environment*, (San Francisco, Jossey-Bass, 1971).

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I. WHAT PURPOSES ARE TO BE SERVED BY WHAT KINDS OF PROGRAMS?

To open the Workshop, the three papers which were presented at the beginning of the Workshop were designed to focus upon the general areas of the Workshop's curricular concerns:

1. the education and training of the ecologist and environmental scientist;

2. the education and training of the technologist and manager of the environment; and

3. general education in ecology and environmental sciences.

These papers, together with statements of respondents included after each paper, set the framework for considering the kinds and qualities of graduates needed in the years ahead and the higher education curricular elements which contribute to their education.

Throughout these proceedings, the presentations reflect the interests of their respective authors. A number of ideas and approaches were thus presented for group discussion and reaction.

Education and Training

of the

Ecologist and Environmental Scientist

Douglas C. Alexander
Chico State College

*". . . [I]t is about time to recognize that we should not set up curriculum to produce four-year products, rather the curriculum should produce well-trained environmental scientists. * * * . . . [W]e should be willing to boldly develop programs based on course need and function, rather than on a complete coverage that, in fact, is not achieved even by the students who do follow a rigorous course sequence. * * * We need an approach to earth and life science courses that demonstrates to the student the reason for taking the necessary prerequisites and advanced courses."*

A brief review of the position of the field of ecology indicates the need for a broad curricular background to understand and use ecological principles. Ecology is a primary discipline of the biological sciences which deal with levels of organization found intact in and composing what we call nature – the population and the ecosystem. Because ecology deals with higher levels of organization, it benefits from the advance in the knowledge of both structure and function of the lower, component organizational levels – the organism and the cell. Ecology actually provides a distinctive approach to all biological phenomena including statics, dynamics and that characteristic aspect of dynamics, development and change through time. Ecology deals with the structure of the highest level of biological organization in *community ecology;* it deals with function and development on this level in *ecosystem ecology* and *succession ecology*. These fields plus *population ecology* and *paleoecology* constitute the major subdivisions of modern ecology. However, the *holistic concept of the ecosystem* also places ecology as one of the fundamental fields of environmental science. The ecosystem concept makes hydrology, meteorology, soil science and geology fundamental to ecology and ecology fundamental to these fields. Oceanography, limnology and soil science deal with all ecosystem components within relatively distinct environments. Thus ecology has both the classical, biological dependence upon chemistry and physics and added relationships through the interdependence of life sciences and earth sciences. As with other sciences, mathematics provides the basis for understanding and expressing many fundamental relationships. Statistical analysis and computer science are also necessary for the ecological approach, especially due to the complexity of systems analyzed.

Considering the relationship of the social sciences to ecology, the structure and function of ecological systems has evolved through the pressure of environmental characteristics that are now being profoundly changed by the action of man. This change is all the more global since the industrial revolution and the development of technology. Thus, man's demands as individuals and as a society are currently environmental factors of increasing importance. Furthermore, many changes in the more detrimental environmental effects could, and do, come from a re-evaluation of man's social action and demands as a society. The very nature of our holistic approach justifies the study of all factors that regulate ecosystems, including human behavior. However, the diverse approaches to training students in environmental sciences are justified only if the study is simultaneously exposed to the holistic concept of the ecosystem. The current ecology dialogue is lending itself to new levels of cooperation between the natural and social sciences. Through both the immediacy of demands, and the vigor of combining different approaches, this is destined to be an exciting and rapidly moving area with many curricular innovations. Specifically, if we want to train environmental scientists to work toward the solution of current problems, they must be able to deal with sociology, economics and political science.

Most of us are familiar with the high diversity and lack of consistency we observe in the offering of degrees associated with environmental science. The size and environmental diversity of California alone provides for numerous distinctive approaches to training environmental scientists within the State College system. Furthermore, due to the wide range in time of college establishment, and the nature of college organization, different colleges have divergent schools, divisional and departmental organizations. These are all good and complementary. For example, the strength and depth of the ecology program at San Diego is matched by the new and innovative objectives of laboratory field-study at Bakersfield. This diversity in approach is certainly excellent; however, all State Colleges should be made better aware of what their sister institutions are doing. This conference is an excellent move in this direction. Furthermore, we should take advantage of this massive State College system with its relatively distinct components, and improve all of our individual environmental science programs. We should encourage student and faculty exchanges at various levels and we should investigate the feasibility of running a roving semester class that would visit various California ecosystems through the use of the diverse State College facilities. The training of environmental scientists is measurably benefited from the personal observations of chronologically and spacially divergent ecosystems. These observations should include systems with minimal and maximal influence by man.

All too many of our degree programs in the earth and life sciences contain archaic hierarchies in course requirements that, at best, are vestiges of previous objectives. The required courses often fail to integrate present-day problems and fail to account for the independence and innovation of our current students. Unfortunately, many of these courses discourage students. In all too many programs, our students suffer under the force of tedium in a time-related sequence of introductory, intermediate and advanced courses. Although there has always been a difference between students and faculty, the current rate of change is so great that our students are children of a totally new culture and environment. We have not prepared our courses for this and we are now belatedly trying to build into classes the needed avenues to accept change. We should also carefully examine all our courses and be willing to establish a new hierarchy of importance. I wish now to consider some problems and operational aspects of environmental science courses.

1. With improving high school science programs, we should be able to omit some of the general survey background classes (as our increasing use of advanced placement tests supports). This is merely recognizing that some students have gained the requirements prior to college. This may become even more obvious as students with less strong high school backgrounds choose community colleges. Thus, rather than updating the introductory courses to keep one step beyond high schools, we should accept the background knowledge and in so doing, encourage our better students to spend more time in advanced courses. If the student failed to gain the general education as a high school student, he can take the introductory courses in either a State College or community college, but after completing this background he should not expect abbreviated college work. There is

nothing magic about four years of college; it is about time to recognize that we should not set up curriculum to produce four-year products, rather the curriculum should produce well-trained environmental scientists.

2. We should be willing to boldly develop programs based on course need and function, rather than on a complete coverage that, in fact, is not achieved even by the students who do follow a rigorous course sequence. There is little doubt about the need for a strong background in mathematics, statistics and computer science; however, a good (not excellent) high school background in physics should be recognized as sufficient for students in biology who could benefit more from meteorology, hydrology, soil science and geology rather than more physics. Alternatively, students majoring in earth sciences with the proper high school biology preparation should be able to enter the biology curriculum at a higher level. Other examples could be taken from biology where classes covering the organ or organism structure on restricted taxonomic surveys should be profitably replaced with structure courses dealing with soils or communities. In this manner, whole curricular patterns should be dismantled and restructured on the basis of demonstrated function in the education of environmental scientists; however, the details of this restructuring will be a characteristic of the local institution.

3. Another problem, especially with survey courses, is the fact that many of the students rarely appreciate the ecological application of many fundamentally important concepts: for example, the relationship of the laws of thermodynamics learned in physics to trophodynamics; the relationship of the chemical nature of nitrate and nitrate ions to biogeochemical cycles; or the true impact of transpiration on local climates. One method of achieving this understanding is the exciting approach proposed at Bakersfield where students will help bridge the gaps between classes by active integration of problems from various disciplines in extended laboratory classes that stress independent research. Another approach that I would advance for institutions with historically fixed introductory courses, would be the establishment of freshmen and lower-division seminars. These seminars would provide relief to the tedium of introductory courses and could be used to illustrate the relationship of environmental concepts to a variety of fields.

Although many of these criticisms are directed at the introductory courses, I do not advocate a total elimination of basic classes. Environmental problems are so extensive that new environmental survey courses which claim to cover both earth and life sciences run the risk of spreading too thin and failing to expose the student to diverse expertise. Although this type of environmental survey appears more logical in training of technologists, and definitely so in the case of non-majors, we need an approach to earth and life science courses that demonstrates to the student the reason for taking the necessary prerequisites and advanced courses. This should encourage students to bring concepts from related courses together into a group research and problem-solving atmosphere. We need to train more individuals with an expertise within some specific aspect of earth and life sciences *but* with an appreciation for the holistic approach.

Although there will always be a need for generalists and synthesizers (and this may be increasing more rapidly due to the knowledge explosion), it is the appreciation for complementary fields that is needed more than the training of generalists. Thus, in my opinion, although there needs to be a much more open and dynamic idea exchange, the historically and functionally established disciplines should maintain some integrity.

The multitude of environmental components and the mass of facts prohibits any attempt at complete coverage. Our training cannot stress the amassing of factual information; there is simply too much information. In contrast, much of the characteristic nature of ecology involves the methods of ecological inquiry. Our students must be trained in principles, and the methods of approaching problems. They must be introduced to the observational-experimental and model construction approaches. We also need to introduce information about distinctive collecting and recording equipment. The use of radioactive tracers, telemetry, elemental and molecular microanalysis and computers represent distinctive aspects of modern ecological research. Our students must also be trained to work in support of group efforts, providing complementary information as specialists.

Students training in the environmental sciences should have personal research experience, preferably as part of an ongoing research program, during a semester or summer unencumbered with academic schedules. One goal of the research should be the application of ecological knowledge to develop a better man-environment relationship.

To be most beneficial, the research phase of the training should come after two or three years of college experience including advanced preparation specifically for the research project. The research phase should be followed with advanced classes which use the student's research observations as basic input information. At this time, the students considering their past research efforts could be profitably used in the preparatory training of further students prior to their research activity. The Systems Ecology program at San Diego State follows such a pattern.

Many of the aims of environmental education dealing with ecologists, technolgists and general education can be achieved through the establishment of a multidisciplinary center for environmental studies. We need centers which have activities that bridge the natural, applied and social sciences, including also people in business and the humanities. The immensity of man's impact on the earth during the second half of the twentieth century is so great that we can no longer approach these problems from academic departments acting as semi-isolated intellectual compartments. A center for environmental studies could function to provide many characteristics and important support facilities that would be used by a variety of courses relating to environmental science. Such activities include:

1. The establishment of a series of permanent terrestrial and aquatic study sites representing as wide a variety of ecological communities as possible within reach of the school. These should include sites with minimal and maximal human impact. They should be used by both introductory and advanced classes as well as providing good research locations for extended observation and experimentation;
2. purchase and maintenance of a fleet of overland, oversnow and overwater vehicles exclusively for use in environmental training and analysis;
3. coordination of environmental data analysis and research programs, including the development of data banks for storage and retrieval of local environmental data for class and research use;
4. establishment and operation of audio-visual and publication programs in the environmental sciences; and

5. coordination of curricular, extracurricular and interinstitutional environmental education dealing with multidepartmental approaches.

This plea for a new approach to curricular support in our institutions that are currently bound to the department, is not pure idealism. In 1958, the Natural Resources Study Committee of the Conservation Foundation identified twenty institutions with multidisciplinary programs in environmental science. Last year, Congressman Emilio Q. Daddario's subcommittee on science, research and development found over 100 institutions with multidisciplinary programs.

In summary:

1. We should accept a variety of training programs for students interested in environmental science.

2. We should capitalize on the potential for institutional cooperation within the State College system as a whole, exploring the advantages that would be derived from roving classes that expose students to the great diversity of environments and environmental study approaches available in California.

3. We should re-examine our current requirements encouraging advanced placement, trying to eliminate unnecessary courses and working to show the student the fundamental importance of a broad course background. This can be achieved through cooperative laboratories or through seminar-discussion classes.

4. The undergraduate education of ecologists and environmental scientists should include the personal involvement of the student in research activity. This should include the study of different ecosystems and time changes in ecosystems.

5. Our objectives can be best served by the establishment of multidisciplinary environmental study centers. These need not challenge departments, rather they should act to bring together units into long overdue cooperative programs.

Response to Dr. Alexander

By

Donald C. Lowrie
California State College, Los Angeles

Although I generally agree with Dr. Alexander's excellent presentation, there are a few things that we can find to discuss in more detail.

First of all, I cannot find much fault in his presenting his report on a broad general basis. I hope that in the future we may delve deeply into many of the specifics of the education and training of the ecologist and environmental scientist: however, we may be able to define that latter term from the word "ecologist," with regard to broad principles and broad distinctions. I find that one of the most difficult tasks is to get my colleagues to agree on the specific contents of a course or a curriculum or what are the major principles that should be covered in any courses or curriculum that could be mentioned.

At California State College, Los Angeles, Richard Lillard and I have been, for the past three months, examining possible courses to constitute a major in Environmental Science from among our school's offerings, from courses we might add, as well as examining curricula of other schools and institutes. We found that development of core courses given in common is a rather difficult problem because of the difficulty in gaining agreement. I believe we should spend some time in trying to agree on a core of courses for the professional ecologist-to-be, as well as for the non-ecologist biologist, the technician, and the general education student.

The speaker stated, "In order to train environmental scientists to work toward the solution of current problems, they must be able to deal [and maybe we can agree on what Doug means by deal] with sociology, ecology, and political science." Rather than this approach, I feel more and more that a team of scientists working on such problems is better for solutions of problems in ecology with its broad nature. One person should not seek to try to put it all together himself. As a spider ecologist, I think I can be most useful in ecological problems where there are predator problems of importance. I can do much with other disciplines that might come into the study of spider ecology, but still it would be better to have extensive consultation with statisticians and other people for the best analysis of problems in any area of this sort. But, maybe this is what Doug does mean by "deal with sociology, economics and political science."

Another idea which I find rather difficult to support, is the idea of a roving, to say nothing of a running, semester class that would visit various California ecosystems and gain information in enough detail to illustrate generalizations about them. Again, if we can agree on what the objectives are, and if they are to have any true meaning to a student, they must be few and broad, and capable of being analyzed in some depth. We may want to survey some of the biomes, but not a great number. I have gradually, in my own presentation of ecology, changed from considering the inter-tidal zone of the ocean, the organisms of a fresh-water stream and lake, the organisms and meteorology and general physical chemical features of chaparral coniferous forest and desert, to considering only the coniferous forest and desert in much more detail than in the past. Studying and comparing the two ecosystems at most, seems to me to be enough to illustrate the principles of what an ecosystem is, what atrophic pyramid of numbers and biomass and energy really are. How completely all biomes, or even many of the California biomes, should be covered is a question that needs more thorough examination although we do have a magnificent selection of major types of ecosystems here in California.

Possibly a quick, superficial transect would be useful. I devised my "poor man's Pines to Palms highway" transect by going over the San Gabriel mountains and on down to the Mojave Desert, rather than traveling further to Mount San Jacinto where there is a little better transect of this sort. So possibly, a quick superficial transect would be useful or maybe several courses on different biomes should be studied in different periods of a student's career.

Doug's comments about leaving the general biology training of the ecologist, or any other specialist for that matter, to the high school (not that they should do it completely, but they should share more of it) sounds great to me. An intensive semester or two-quarter course bringing the students up-to-date might be good. If we can agree that an undergraduate can specialize in ecology for example, rather than the broader biology or even botany or zoology areas, then an intensive course in the areas in which he will eventually specialize would be a more efficient use of his time than to have a series of in-depth courses in these areas. At present, I feel the specialist needs much more depth in his chosen area. We may now be giving him a program of courses which round him out until he is an unstable ball with nothing brought to a sharpened point. Likewise, I feel that if he has had a good year of high school physics and another of chemistry, many prospective ecologists may not find it necessary to indulge in a general course in this area but can specialize in heat, or light, or organic chemistry, or some more specialized area he may need for his own chosen area of ecology. This is very controversial, I am sure, and whether we can come to a new approach is certainly something for the future.

On the other hand, I would stress more taxonomy, at least of certain groups, rather than less. Each species has become what it is because of its ecological adaptations to certain optimal and limiting features of its environment. Taxonomy is certainly one of the most important tools in many areas of ecology, such as studying a particular biome in detail, or the plants of a particular ecosystem, or the land arthopods and related forms of duff and litter. To take my one particular experience, I specialize in the spiders of the genus *Pardosa*. I am trying to get at the isolating mechanisms involved in a closely related group in which much of the taxonomy I have to do myself.

Two remaining comments: some research at the undergraduate level would seem to be imperative for those who are going on into technical training as well as those who are going on for a higher degree – which too often involves isolating a problem usually set up by the major professor. Students should have the opportunity of designing experiments or taking observations to make the most out of the statistics, and should have the time available to gather the data. The original research I try to get my students to do needs planning to excite them about problems and their solutions. Just telling them generalizations or suggesting research seems hardly enough. All of this needs careful planning. The suggestion of a summer research project, as San Diego State is doing now, seems an ideal way to provide this research experience for the undergraduate.

Finally, I am not in favor of a fleet of swamp-alligator-snowmobiles or the various pieces of complex apparatus for each college. The need for swamp-alligators and the like ebbs and flows, and no one college is really equipped for such care and maintenance, especially if one staff member who has been using such equipment leaves and the new person has no use for it. They all have a time and place, but the equipment should be State College system owned and maintained rather than by an individual college.

Education and Training

of the

Technologist and Manager of the Environment

Paul L. Kleintjes
California State College, Long Beach

*"The present state of our technology is capable of providing the means to turn the tide of pollution. To do this, people must have the will and the know-how to apply it. * * * In some respects, everyone is a manager of some aspect of the environment. Whether as an individual or as a member of an industrial enterprise, there are basic needs which can be met through education."*

I suspect the purpose of these short presentations is little more than to set the stage, bring the problems into focus and start some controversy on solutions. The main effort will come in the second phase, when ideas are jelled and proposals formulated.

This good earth is rapidly facing devastation. The utopian schemes, whether of Genesis or the modern philosopher, stand slim chance of fulfillment unless workshops such as this produce some sound practical solutions to the manifold problems of the ecological rescue through education.

Whenever something or some plan goes awry, it is the human tendency to fix the blame on someone else. It is like the pregnant wife who accuses her husband of being unfaithful because he is not the father of her child. Of all suspects, and we shall name a few, the ultimate cause is "people" and I must hasten to add, I do not mean just *too many* people, but people like you and me who really don't think "we are of the 'too many'."

And so it is with the devastation of this good earth. Quick to be blamed is the technology, the automobile, the oil refinery, the power plant, the steel mill, the sewage system, *ad infinitum*.

What is the scope of this threat? To unify our perspective, here is a quick summary of some problems and causes.

Air – photochemical smog – the auto, microparticles, the cement industry, sulfur dioxide and other industrial gases, the heavy industries, chemical and oil industries.

Water – agricultural pesticides and fertilizers, oxygen demanding wastes, infectious agents, sewage, solid wastes, industrial chemicals, radioactive substances, and heat.

Land use – deforestation, erosion, overgrazing, refuse disposal, tract development.

Animal and Plant life – poaching, poisoning, fish-outs, blight on plants, trees and shrubs.

Archaeological and historical – the stealing or destruction of artifacts, pictographs, old ghost towns and pioneer sites as Darwin, Telluride, Silverado.

Some devastation is due to avarice, some to vandalism, some to ignorance, but all to people.

People – Too many? Who here volunteers to eliminate himself? Too many in one place? Fly over North Dakota, Kansas, Texas, Colorado. Who is ready to move?

These problems have been aired many times, seldom without passion or prejudice.

Ernest Furguson writes of Environment's Three Foes: Industry, Labor and the Consumer.[1] He cites the common misconception that the public is at last alerted to the long-range danger to our environment and all that is needed is the enactment of a few safeguards to clean it up. He continues that, on the contrary, industry, labor and even the consumer at large are going to be either hostile or indifferent to cleanup measures if there is the remotest chance that it will cost them a sale, a job, or a buck.

In Oregon, a proposal for a deposit on soft drink and beer containers to reduce litter on beaches and parkways, with a five to one sympathy poll, went down to defeat in the elections when vested interests convinced the voters that such a requirement would cut jobs and increase costs. Lobbying pressure killed the 1.6 billion dollar anti-pollution tax on leaded gasoline. According to the *Los Angeles Times* some $333,445, contributed mostly by oil companies, helped kill Proposition 18 in California.[2]

In Phoenix, Arizona, an opportunity was extended to the car owners of that community to equip pre-1968 automobiles with a pollution control device at $20 per vehicle. Of the 336,000 vehicles eligible, only 528 were so equipped.

There are too many instances of less than rigorous action on the part of our public institutions, city, county, state and federal, to enact or even enforce the legislation needed for adequate control and cleanup.

Fines, sometimes imposed for violations, are often ridiculous. It's less expensive to pay the fine than make the outlay to correct the source of pollution. For example – noise level violations for aircraft carry a $1,000 fine. How do you de-noise a $5,000,000 airplane?

Cost is probably the greatest barrier to effective action. In *Applying Technology to Unmet Needs*, a report of the National Committee on Technology, it is estimated that the cost of cleaning up the Potomac River for swimming by 1975 would be $2.5 billion, Lake Erie, $20 billion.[3]

Not all industry, however, is shirking its collective responsibility. In their fine house organ, DuPont's ***Better Living***, Dr. Samual Lenher, past chairman of DuPont's Environmental Quality

[1] *Los Angeles Times*, November 30, 1970.
[2] *Ibid*, December 4, 1970.
[3] "The Attack on Pollution, We're in the Third Phase", Sept. 10, 1970.

Committee, points out that industry is slowly responding to its all too apparent social responsibility. DuPont, alone, has some $150,000,000 invested in pollution control facilities, has the equivalent of 1,000 employees engaged in research and control, and has an annual budget for pollution control of $30,000,000 per year. He writes of three phases in the attack: 1) recognition, 2) arousing public concern and enlisting interest, and 3) involvement, which is just getting under way.

The National Association of Manufacturers indicates that industry is currently spending $500 million a year for air pollution control. Members of the Western Oil and Gas Association are asserted to have spent, in Los Angeles County alone, over $155 million on operation and maintenance of controls over the past twenty years. Kaiser Steel in Fontana employs control measures said to be 99% effective in reducing objectionable effluents, at a cost of $17 million.

As for involvement, the acceptance by industry of "Control as a Social Obligation" is the key.

And now we have gone full circle and we are back to people. For in the final analysis, government, industry and society are people. The present state of our technology is capable of providing the means to turn the tide of pollution. To do this, people must have the will and the know-how to apply it.

Because of its extreme complexity, air pollution control alone calls for an exceptionally large number of professional disciplines. These include among others, physicians, engineers of many specialties, chemists, physicists, veterinarians, plant pathologists, toxicologists, meteorologists, biologists, economists, lawyers, statisticians, public health nurses, health educators and city planners. All of these must have a good working knowledge of technical factors peculiar to air pollution. In addition, skilled persons are needed to design, fabricate and service the devices for control. Multiply this list by the other areas of environmental pollution mentioned earlier and the list seems endless.

Put the technology to work, and the jobs, careers, products, and markets rising out of the antipollution effort will satisfy the most pessimistic. The economic benefits are a bonus to the basic reward of continued existence.

And now a look at "Education for the Technologist and Manager of the Environment." In some respects, everyone is a manager of some aspect of the environment. Whether as an individual or as a member of an industrial enterprise, there are basic needs which can be met through education.

The non-technologist in industry needs some knowledge of technology to be able to recognize the technical capabilities and limitations, cost, time, and side effects of proposed solutions. For example, in order to make intelligent decisions concerning air pollution, he needs some general knowledge of the technological control measures available, their efficiency, cost and application. Systems which employ principles of filtration, electrostatic precipitation, centrifugal force, scrubbing, vapor recovery, combustion, and solid absorption are among those currently available. He should be familiar with them.

Most industries use great amounts of water and the techniques of pollution control and waste recovery are as complex as for air. He will need to understand and be able to evaluate such processes as: absorption, separating organic impurities from liquids, electrodialysis, removal of dissolved mineral matter from solution, foaming, removal of active surface impurities, and coagulation, and removal of suspended and colloidal solids and algae nutrients. In addition, there are other techniques under development which will be available to him as: evaporation, chemical oxidation, ion exchange, freezing, and reverse osmosis.

The removed pollutants and salvaged waste poses a secondary disposal problem which calls for imagination or "imagineering." Examples of successful systems are: yeast from paper mill sulfite liquor, animal feed from fermentation residues, and non-dairy cheese from the brewery. Waste recovery and use makes pollution control a source of profit and helps meet the cost of the processes.

The manager must be technically creative. He needs a general environmental science experience rather than the traditional biological or botanical program. He needs to develop a sense of social responsibility, self-control, self-denial, pursuit of excellence, and morality, if you will. The great immorality of today is the cult of self-indulgence and the refusal of responsibility.

The technologist in industrial management must be aware of the problems and dangers facing the environment – he too needs an environmental science experience. He must have a technology oriented to ecological processes and their preservation. He must have a sense of social responsibility, the same as the non-technologist. (During the past few semesters, I have seen some good signs of awakening ecological consciousness. Students in the industrial technology program almost always move into management positions. In my classes, concerned with materials and processes of industry, questions are being asked and possibilities discussed that relate to environmental pollution and its control. This is new. We plan to include information and discussion on environment and are making appropriate changes in course content. Industrial social responsibility starts with the individual.)

Not only must the technologist of the environment be acquainted with the technical means and methods of pollution control but, in addition, he must be capable of designing, fabricating, operating and maintaining the systems. His greatest problem will be keeping up with advances in technology. This will be due in part to the sheer volume of new technology being generated, the rapid pace of its discovery and the technological gap between the military/space/nuclear sector and the main body of the economy. Specialization will become increasingly more crucial as the sheer complexity and sophistication of technology preclude the possibility of anyone grasping an understanding of more than a miniscule part.

From where I stand, it appears that the problem revolves around people, their attitudes, their morality, their comprehension of, and respect for, technology. Education with a new format can help to solve the problem.

We need to develop an interdisciplinary program with contributions from many areas. We must abandon traditional course structures and empire building. We must abandon the cherished idea that the liberal arts, general education, engineering technology or any one of a host of disciplines holds the answer.

We need the courage to strike out with a new concept to meet a new and immediate need. There is no tradition to hinder us – what a challenge! What an opportunity!

Response to Dr. Kleintjes

by

Kenneth Teel
California State College, Long Beach

I would like to support very strongly, three points that Dr. Kleintjes made – first, people are indeed the problem. If we could somehow cut the population in half, most of our ecological problems would go away. But we find very few volunteers to this.

The second point that Paul made is that technology currently has far more of the answers than are being implemented. If we could just put into effect many of the techniques that are currently available, we could make a significant impact on our total environment. We could reduce air pollution, water pollution, and noise pollution. True, we could not eliminate them entirely, but we could make a significant reduction to a point where people would back off and stop worrying for awhile. Perhaps it is just as well that we are not implementing as much as we know right now until we come up with some final answers. Currently, we know a lot more than we are using. This, of course, is true of all knowledge.

The third point I would like to underscore, before I start disagreeing, is that everyone is a manager. At first I was going to criticize Paul because he did not define "manager"; however, he later pointed out that everyone of us is a manager in one way or another. We all manage something, albeit, in many cases, precious little. The only difference is the extent of the influence of the manager. Over what area does he have some responsibility and control?

The speaker made the comment that he thought it was necessary that the industrial manager have a fairly detailed understanding of the technical details of how to control and improve the environment. I feel, instead, that he needs to have an appreciation of the problem and know when to call for help from his technical staff members. We are always saying that the manager should know how to do this, that and the other thing. Finally, you could end up with someone who would have to know all about everything and who in fact, could only know a smattering of a few things. The ability to know where to get the right information is most important.

A fourth point on which I would like to react is Paul's statement about the importance of social responsibility, and certainly we see this to an increasing degree on the college campus now. Students talk about it more, but I do not know how much of this talk is really being translated into action. I think that many of the students are sincerely interested in conservation, ecology, helping the handicapped and many other areas. For example, many students are giving freely of their time to go into depressed areas to help train children. Many do have a serious interest in improving our society. I feel Paul passed over this a little lightly. He left me with the impression that somehow social responsibility is going to rise to the surface without anyone working to make it do so.

Personally, I feel one of the most important areas of training for the manager of the environment, or the technologist, or anyone else who is going to be involved in this area, is in value systems in modern society. I think the important point, when we are talking about industrial contributions to deterioration of the environment, is that currently our social system is such that there is no inherent reward for the company that does indeed take steps to control its emissions. In fact, there is a negative incentive built in – such companies make less money. Anybody who is proposing a training program has to hit directly in this area – what are the values? What are the social responsibilities of the citizen, of the community, and of industry as a member of that community? The primary goals of business basically are to survive and make money. These are pretty much the same as for everyone of us. We want to stay alive and we want to make a certain amount of money, but the question we have to ask is: Are students really aware of the impact of large expenditures of money on pollution control, upon the profitability of the organization and even upon its ability to survive? I think we need some in-depth consideration of value systems as an integral part of the curriculum.

My last comment is that I think we have overlooked the importance of socio-political solutions to the problems. I think we have to muster socio-political support for our programs to preserve our environment and to improve the ecological balance. Therefore, I would strongly recommend that anyone who is studying in this area, or who is developing curricula in this area, must include in it some hard looks at propaganda techniques, at human attitudes and how they are formed, as well as how they can be modified by political action. How do you get the State Legislature to pass a law which will put stiffer penalties on violators of the environment? Legislation is going to be essential, but to get the legislation we are going to have to muster a lot of popular support and this involves social and political action programs.

So, to summarize my brief comments, I would support Paul on his statements that (1) people are the problem, (2) technology has a lot more answers than we use, and (3) that all of us have some responsibility for improving the world in which we live. I differ with him, though, in that I think the manager does not need to be the technologist himself. Also, we have got to include in our training, in-depth examination on value systems. Furthermore, we also have to sensitize anyone who is studying in this area to ways of putting his recommendations into action. We can come up with the world's best programs, but if we can't sell them to anybody they are worthless.

General Education in Ecology and

Environmental Sciences

Albert W. Johnson
San Diego State College

> *"The environmental crisis is not a transient phenomenon. The problems are substantial, pervasive and complex. * * * Successful solutions to them will require fundamental changes in the way people think and act. Failure to solve them will lead to breakdowns in one or more concerns of the society such as agriculture, transportation or health. If the problems are ignored, catastrophe will occur. Everyone should know these things; certainly all college students must know them. The curricular problem is not shall we include courses about ecology, but how can we do it best."*

Although the words *ecology* and *environment* are used almost interchangeably, they refer to different concepts and ought to be distinguished from one another. Those physical and chemical phenomena that interact directly with the organism comprise its environment. Neither the organism nor its environment exists separately, so the use of the term "environment" is mistaken unless an organism is present. That branch of science that describes and defines this relationship is ecology. Courses in climatology, geology, physical geography, soils, and the like are useful preparation for understanding environmental relations and thus, for studying ecology, but they are not in themselves environment courses. Therefore, in discussing the environmental sciences and general education I should like to limit myself to what is primarily ecological and secondarily environmental.

Apart from the primarily professional aspects of ecology, concern about ecological and environmental issues has caught on with a substantial minority of students. What most of this group wants from a course could best be labeled "human ecology." Specifically, what are the effects of a modified environment on man and other organisms and what can be done about it?

Before making specific remarks about curriculum, another point should be made. The environmental crisis is not a transient phenomenon. The problems are substantial, pervasive and complex.

While it is probably true that some of the initial enthusiasm about solving environmental problems was of the sensational variety, interest in and action on these problems will continue into the future. Successful solutions to them will require fundamental changes in the way people think and act. Failure to solve them will lead to breakdowns in one or more concerns of the society such as agriculture, transportation, or health. If the problems are ignored, catastrophes will occur. Everyone should know these things; certainly all college students must know them. The curricular problems are not: shall we include courses about ecology, but how can we do it best?

In many colleges and universities, courses dealing either directly or indirectly with ecology are already available to students. Usually they are associated with the sciences, and most of them do not meet the needs of the general education curriculum because they have substantial prerequisites. The junior level ecology course at San Diego State is a good example: it requires a beginning biology course, elementary chemistry, and a course in biostatistics.

Courses at San Diego State College suitable for introducing ecological ideas and which are available for general education credit fall into three categories:

1. Department-centered courses at the lower-division level. As often constituted, many of these are weakened modifications of the introductory course in the field. Example: Biology 1 (no laboratory requirement).
2. Interdisciplinary upper-division or lower-division courses especially designed for the non-major. Example: Oceanography 100, The Oceans; College of Sciences 99, The Environment.
3. Second-level upper-division department-centered courses, usually with one elementary prerequisite. Example: Biology 115, Conservation Ecology. (Outlines of these courses follow these remarks.)

All of the courses are variously ecological, some exclusively so. The Biology 1 course was designed three years ago at SDSC to make the course more appropriate to the needs and interests of the non-majors for whom the course had been intended. The outline of the chemistry course is new; it is intended for social science majors for whom a new option in the environment will soon become available. College of Sciences 99 grew out of our attempt to provide a single interdisciplinary course on ecology and the environment for non-science majors, and to avoid overlap and proliferation of environmental courses. Biology 115 took on its present ecological emphasis about four years ago. All of these courses have attracted students. Their total enrollment in Fall 1970 is approximately 150 FTE, while in Fall 1967, it was about 50 FTE. More significantly, the courses experienced a 100 percent increase in the percent of total FTE at the institution during that three year period. With new options proposed in the environment and more curricula recognizing the importance of including some environmental offering, the demand is bound to increase in the foreseeable future.

Despite the relative success of this rather piecemeal approach to the inclusion of ecological information in the general education curriculum, we are reaching something less than one percent per semester of the total student body at San Diego with courses that have a large ecological content. Naturally, other traditional courses with low ecological content reach others.

What Should be Included in Environment Courses

As with any course worthy of inclusion in a college curriculum, courses dealing with environmental matters must be more than a topical recitation of today's environmental horror stories. The fundamental nature of the problems must be made clear. It is equally important to put each of the problems discussed in an historical perspective that illustrates a common origin for many of them. For example, early economic policy and legal decisions favored a hands-off attitude on the part of government vis-a-vis industry. The implications of present actions about the environment should also be included, although this is a more difficult area for objective discussion. The question of what can be done about a variety of environmental problems, specifically corrective action, is important, but inasmuch as that question inevitably becomes "what shall we do about the problems" the instructor may find himself in the middle of a student-generated action program, particularly if he is an effective teacher. It is difficult to discuss the problems that have been associated with DDT without implicitly condemning those who make and use it.

I shall discuss each of these points briefly.

1. The Nature of Environmental Problems

Environmental problems are complex even in their narrowest scientific aspects. When they are extended to include man they are complicated by a variety of social problems as well. They can be dangerously oversimplified to naive audiences. If the problems are to be discussed as a part of a course in biology, the student should be given sufficient background in genetics, physiology, and ecology to understand the ways in which the environment and its modifications affect life. The potential dangers of radiation damage from fallout of power plants means relatively little unless the relation of ionizing radiation to the structure and physiology of cells is pursued in enough depth to allow the student to generalize about the effects.

Environmental problems are also excellent material with which to demonstrate experimental design, the scientific method, and the use of statistical procedures.

2. The Background of the Problems

It is important that the student understand why or how environmental problems came about. A substantial literature is developing on this point. The problem of human population size inevitably appears here, as do western attitudes about nature, legal and economic policies that have encouraged pollution, expanding GNP, the philosophy of the frontier, and the like. While it is a fact that some of the environmental problems result from new and unique inputs (the DDT problem, for example), most of the problems are old ones that are quantitatively larger because of larger population and increased consumption. Unless this aspect of the environmental problem is explained, the student will be at a loss when it comes to putting all of these issues in a meaningful perspective for himself.

3. The Future

Apart from a few of the most widely discussed cases of contamination of the environment, it is still highly speculative to predict specific consequences of current practices. Is the CO_2 concentration of the atmosphere directly related to its temperature? How rapidly will the population of the United States increase? What are the consequences of increased amounts of lead in the habitat? What are the safe limits for a variety of contaminants? Questions of this type constitute an added reason for making certain that the student receives a basic understanding of the problem.

4. Action Programs

Due to the critical nature of environmental problems, the instructor inevitably finds himself confronted with involvement in the social, economic, and political issues stimulated by the course.

Despite efforts to remain objective and detached, the tendency to expose half-hearted or non-existent attempts on the part of government and industry to ameliorate pollution problems is strong. The borderline between objectivity and political action is fuzzy in these cases. In the light of attempts to depoliticize the colleges and universities, some problems are certain to arise here.

Conclusion

It is probably wise, for the time being, to offer ecology and environmental science courses to general education students under a variety of headings. Because such courses involve considerable overlap in content, it is appropriate for departments to work toward cooperative courses in the area. In my opinion, at least one ecologically-oriented course should be a general education requirement. This requirement should be implemented as soon as is practical, given the current financial constraints on the institutions. Inasmuch as environmental issues will be of continuing interest for the foreseeable future, planning for meeting the long-range needs in this area should be a continuing function of the institution.

San Diego State College

Proposed Outline for Chemistry for the Social Science Major
To be taught as special sections of Chem 2A-2B (no lab)

There will be three 50-minute class meetings per week or two 50-minute class meetings and one 2-hour discussion problem-solving session.

On Monday and Wednesday, chemical theory will be emphasized. Relevant examples will be used.

On Fridays, environmental problems will be discussed based on the chemical theory taught earlier. Occasionally, new theory will be introduced if needed.

CHEM 2A

MONDAY-WEDNESDAY TOPICS

The Nucleus: fission, fusion, belt of nuclear stability, $E=mc^2$
(about 2 weeks)

The Atom: atomic structure, Bohr atom

The Periodic Table: concurrent with The Atom

Chemical Bonding: octet rule, ionic bonds covalent bonds, polar bonds

Light and Energy (may be concurrent with The Atom)

Water: hydrogen-bond, solvation of ions, dipole moment

Classes of Chemical Reactions: chemical equations

Organic Chemistry
- Alkanes and sulfonate derivatives
- Alkenes and phosphate derivatives
- Aromatic Compounds
- Alcohols
- Aldehydes and ketones
- Carboxylic acids
- Amines
- Esters and amides
- Amino Acids

FRIDAY TOPICS

Significant Elements of the Environment:
(Overview of environmental topics)
Nuclear power and thermal pollution

Radiation and You

Cosmic Rays and the Solar Wind

Systems Concepts and the Ecosystem

Introduction to Smog

Water-Related Topics:
- Why the sea is salty
- Heat and climate

Petroleum Industry
Combustion, burning and energy release
Smog (continued)
Polyethylene and Teflon

Other Polymers and their Degradation
Dacron, nylon, vinyl chloride
Soaps, Detergents, and Bubbling Sewage Plants
Why lakes die

Proteins and Genes

CHEM 2B

Organic Chemistry (continued)

Natural Products

Steroids

Alkaloids

Terpenes

Introduction to Biochemistry
(Emphasis on metabolism, genes,
(and life-cycles)

The MOLE

Solutions

Thermochemistry and Equilibrium

Kinetics and Mechanisms of Reactions

Catalysis and Enzymes

Metals, Their Structure and Properties

Refractories

Fluorine, Fluoride, and Fluoridation

Birth control through use of steroids
(The pill and how it works)

The Drug Scene From the Chemist's View

Cracking Tires, Aging Rubber,
Brittle Plastics and More on Smog

Fire Storms and Chaparral

Food Additives

Chemotherapy

Pollution by Heavy Metals
Mercury, lead, and what next?

Pesticides
DDT and pseudo nerve gases

Nerve Gases and How They Work

Biogeochemistry
Properties of Metals
Corrosion of Metals

San Diego State College

College of Sciences 99 – THE ENVIRONMENT – Fall 1970

Required readings in: 1. Kormondy, "Concepts of Ecology," Prentice-Hall, 1969.
2. *Environment* Magazine

Orientation
The Environmental Crisis
The Environmental Sciences

The System Concept
Origins of Earth, Oceans and Atmosphere
The Physical Environment
Solar Radiation and Energy Flow
Origins of Life
Photosynthesis and Productivity
Energy Flow and Tropic Levels
The Importance of Water
Biogeochemical Cycles

Aquatic Systems and Eutrophication
Chemical Residues
Photochemical Smog
EXAM
Populations and Communities
Chaparral and Ecosystem Management
Fisheries Management

Power, Reactors and Radiation
The Requirements for Power
Nuclear Contamination
Ecological Effects of Power Stations
Radiation and Genetic Damage
Mineral Resources

Environment and Public Health
Human Ecology and Disease
Environmental Stress
The Psychological Environment

San Diego State College

Schedule for Biology 1, Fall 1970

Week	Lectures	Discussion
1	Introduction Scientific Processes	Responsibilities of Science
2	Physical Environment Biological Compounds	Water as a Resource
3	Cell Structure Types of Plants	Effects of Ozone on Lung
4	Types of Animals Energy & Respiration	Entropy in the World
5	Photosynthesis Midterm	Effects of DDT on Photosynthesis
6	Nutrition Gas Exchange	Effects of Ozone on Plants
7	Blood & Circulation Excretion & Osmoregulation	Physiological Effects of Lead
8	Neuromuscular Physiology & Behavior	Effects on Cholinesterase of Organophosphorus Compounds
9	Reproduction Growth & Development	Action of Weedkillers on Plants & Animals
10	Basic Genetics Midterm	No Discussion Holiday
11	Origin of Life Evolution & Natural Selection	Is Man a "Natural" Being?
12	Ecosystems Population Dynamics	Ecological Problems of the Aswan High Dam
13	Food Webs & Energy Flux Biogeochemical cycles	"Efficiency" of Man's Diet
14	Man & Environment Human Reproduction	Man & Energy – What are the limits?
15	Birth Control Methods Important Biological Questions	Public Health Tolerance Limits Course Evaluation

San Diego State College

Biology 115 – Conservation Ecology

General: This course carries three semester units of credit and meets twice weekly. It is available to students, both majors in biology and non-majors, who have had an introductory course in biology.

Schedule:

Session Number	Topic
	Introduction
1	The Ecological Crisis: General Nature
2	The Ecological Crisis: Cultural, Philosophical, and Economic Roots
3	The Ecosystem Concept: Introduction and Discussion of Major Processes of Energy Flow and Nutrient Cycling
4	The Ecosystem Concept: Dynamics of Succession and Population Regulation
	Problems Relating to Ecosystem and Energetics
5	Vegetational Management: Dynamics of Nutrient Cycling, Fire, and Ecological Succession in Relation to Management
6	Vegetational Management: Interactions of Vegetation and Animal Populations
7	Wildlife Management: Wildlife and Habitat
8	Wildlife Management: The Role of Predation
9	Pest Species Control: Shortcomings of Artificial Control
10	Pest Species Control: Biological and Integrated Control
11	Pest Species Control: New Techniques
12	Human Populations: Causes and Patterns of the Population Explosion
13	Human Populations: Food Resources and the Green Revolution
14	Human Populations: Population Control
	Problems Related to Chemical Cycles
15	Pesticides: Problems and Direct Side Effects
16	Pesticides: Food Chains and Indirect Side Effects
17	Radioisotopes: Pollution and Food Chains

Response to Dean Albert Johnson

by

Glenn A. Flittner
San Diego State College

It has become obvious to me that all of us have been speaking to several major points either directly or obliquely, but underlying all of this discussion seems to be a major theme: How are we to develop an ecological awareness in the body public? I have heard it said here that, at the present time, the people who have this concern are in the minority. In my view they must constitute the majority in the future. We have recognized the population problem; Malthus did too and more recently, Ehrlich and Commoner, but so far we have not learned too much in reading the historical archives. We are indeed faced with the problem of developing an awareness of how man relates to his environment. The question of "too many people" is a relative one because our value systems today are quite different from those of one hundred years ago – and the judgments that we may make today will be quite different from those of one hundred years from now.

But it is quite obvious to many of us today that we must consider the total system. This concept is very important. We are just beginning to appreciate what it is. It is obvious to me that anything that we do as individual human beings has an effect on other people in this total system, other organisms and other parts of the environment – just as the stone, thrown into the pond, produces ripples which fade into such small scales so that you can no longer distinguish them; but they are still there and can be measured.

We are beginning to recognize the necessity for an informed world community. In our society, that community happens to be the voters. And, as a consequence, they do have a good deal to say about what our nation should be doing in the future with respect to our environment and our resources.

Another concept has come upon us – and our students have appreciated it much more than we have – the concept of the Space Ship Earth. The Apollo 11 and 12 missions brought this graphically home to the entire world, but especially to our culture because we all have at least monochrome television sets. We do inhabit a finite sphere. It does have limits; we can see them now. We must stimulate interaction between segments of the total human community the world around. The historian and the lay individual are just as responsible as we ecologists.

Still another concept with which we must deal is a point of view – destruction, exploitation, utilization, or whatever you may call it. These are the inevitable aspects of man's need to survive on this planet. So the more numerous we become, the more destructive we may become. We have always exploited our environment for our own personal sustenance, whether it was hunting buffalo or relentlessly pursuing the wild fish stocks of the world's oceans, for example.

Another concept which has arisen from the discussion here is one of public attitudes: the question of the doomcrier versus the pragmatist of today. None of the present-day ecological issues really have deterministic solutions. In my view, it is always a question of trade-offs. The value system of man must be considered in resolving the trade-offs. It is quite obvious that some of the trade-offs we have made in the past are no longer acceptable. There are limits to growth *per se*, – is all growth good? I think the answer is "no."

We have also recognized the necessity of interchange of information which has already been generated by our scientific and technical community. There is a wealth of information, but how to mine it, how to get it out so we can use it is really the problem. This is a technical problem in my view and I think the computer age is going to put us into the business of using these data more effectively.

Finally, one additional observation comes from the previous discussion – man is a manager in every sense of the word: He is indeed the manager of his own destiny.

II. SCIENCE AND TECHNOLOGY: THE QUESTION OF EMPHASIS

*"I propose that the focus of higher education in the State Colleges of California be reoriented to a consideration of human ecology from every aspect. * * * The emphasis would be on technology and function, with the fundamental concepts carefully built into the program as a block of core courses."*

— *R. G. Lincoln*

"In the development of knowledgeable leadership, it would seem that a series of interdisciplinary degree programs are needed between science and technology departments and humanities and business departments."

— *John Hutcherson*

*"I doubt that courses in 'pollution appreciation' will prepare business men, politicians and public officials for making wise decisions about the environment without the backup of hard-nosed science. * * * I wonder whether . . . we still intend to fight the curricular battles of the romantic period."*

— *Kenneth E. Maxwell*

Building upon the preceding formal presentation, a panel directed its attention to the question: which to emphasize, science or technology, in curricula devoted to ecology and environmental science? The position statements for each of the three panel members follow.

Technology and Higher Education

R. G. Lincoln
California State College, Long Beach

The achievements of science are truly legend. We live today in mechanical and electronic splendor that would have boggled the mind of the wealthiest potentate of a century ago. We look ahead anticipating a future planned by the computer, sustained by the limitless energy of the fusion reaction, and poured from a cornucopia of test tubes.

As with art, science is a creative process. The spawning ground of a new hypothesis is a free and unbridled imagination. Although computers serve science in doing the yeoman work of information storage, problem-solving, and systems evaluation, the indispensable base of science is the innovative capacity of the human mind, unmatched by any computer yet devised. In the past, attempts to direct or divert scientific thought have invariably resulted in unproductive or counterproductive consequences. One example was the collapse of classical genetics in Russia with the pseudoscientific polemics of Lysenko. More recently, the sayings of Mao and the excesses of the "Red Guard" have provided a mental climate non-conducive to the development of functional science in China. In contrast, the U.S., Britain, Germany, and Japan lead the world in an ongoing scientific proliferation that may be assessed as only the initial phase of an infinitely expanding continuum.

Science and technology are two parts of a coupled system. Without technology, science would be simply a gigantic mental abstraction. Science is manifested in technological innovations, and science must be translated into activity through technology. Whereas science is spawned from an undisturbed mental gestation, technology is moulded and appended to a purpose and is oriented to a specific goal.

We can justifiably be proud of the sophistication of our sciences and of the technology that has transplanted the human heart and has generated electricity from the atom. The situation, however, is strangely inverted. In a nation that placed men on the moon, municipal water averages 50% sewage. Mississippi water, by the time it has reached New Orleans, has been drunk and excreted 50 times. Although we have the finest medical facilities in the world, the life span of the U.S. male is now exceeded by the males of 25 nations of the world. The lead from gasoline additives has entered the food chain, and every U.S. citizen sustains a subclinical case of lead poisoning. The cities of the western world are spectacular concentrations of buildings, machinery and facilities, activities and people. In terms of monetary investment and technological activities our cities are enormously impressive. In terms of human habitation our cities are disasters steeped in poisonous waters and noxious atmosphere.

On a global scale, 65% of the one billion children now alive in the world will not live to attain age six. Two-thirds of the world's people are presently starving or on inadequate diets. As the global population doubles by the year 2000, the supply of food for each mouth will decrease with catastrophic results. The ecological problems of our nation and of the world are now of crisis proportions. Survival of the human race is at issue.

We simply cannot wait for a new theory of ecological relativity to burst over the scientific horizon. We must instead direct our existing technology to this problem. We have the means to produce more food. We can move strongly to slow world population growth by implementing all known methods of birth control. Pollution, being a normal consequence of all human activity, can never be eliminated completely, but it can be minimized. Since pollution occurs as the consequence of misapplied and mismanaged technology, a less expedient technological philosophy will rectify to a very large extent our current pollution problems.

The ultimate answer to the problems of human ecology will be derived from future discoveries in the basic sciences. However, if we defer current problems to some indefinite time in the future when science will have provided new information, these problems will then have evolved to dimensions that will require yet further research to provide a second generation ultimate answer. The problems of today must be dealt with in terms of technology now available.

With 60% of each high school graduating class seeking admission to college, the curriculum of our institutions of higher education should reflect the needs of our society – but is this actually the case? With the survival of mankind in question from converging problems of overpopulation, hunger, and pollution – we continue to flood the country with degrees in disciplines that have restricted vocational outlets and little relevance to the over-riding problems of mankind. How desperately does Long Beach need the 1,000 history degrees that are currently being processed? Should we inform the parents of these students that this four-year investment of their money and their son or daughter's time will in all likelihood improve their offspring's social poise and render the degree holder a more enlightened voter but the degree will be for the average student a vocational disappointment? Will classes continue to be filled with bright, young faces when it becomes obvious to all that we are overproducing engineers, chemists, geologists and every other degree listed in the catalogue? Are freshmen physics majors aware that there are 30 applicants for every opening in physics? At Long Beach State we have over 900 biology majors. Our program is pre-professional, and we take considerable pride in its rigor. Only a small percentage of our students enter medical or dental school. Fewer will be entering graduate school next year than have in the recent past, and the outlet for placing teachers at any level is becoming increasingly bleak.

We seem to be participating in a ritual evolving out of a 1940 vintage dream of fame and fortune for "Everyman" via the college degree. The dream is sustained by periodic pronouncements giving statistics to show the life-time earnings of the college graduate to be significantly higher than that expected to accrue from the vocational gleanings of a high school dropout. These statistics have not been adjusted to account for the college graduate who happens to also take over his papa's store. No one has determined the frequency of those positions requiring a college degree of all applicants, not because the nature of the position demands a background in literature, history, and sciences; but simply for the reason that B.A.'s are abundant and readily available at bare subsistence salaries.

Every student who as a freshman declares himself as a biology major envisions a future as a scientist or a physician. Statistically the odds are not in his favor. By offering the teaching credential, we have traditionally eased the disappointment of the C+ or even B grade student, whose grades are short of the academic mark for admittance to medical school or graduate school. Now that most school districts have reached a plateau in their growth, fewer new teachers are needed than had been in the recent past.

While it is not feasible to attempt programs in liberal arts and sciences education that carry a guarantee that the student will have employment with the degree, we can and should make education practical and timely. Currently liberal arts and the sciences are neither. Biology majors in their senior year often cannot prepare a molar solution of a salt or mix a buffer. Most science students upon graduation are functionally helpless in any practical pursuit of their discipline. If education is truly current, relevant, and practical, the degree recipient will then have clear worth in the professional market place.

The crisis of our times is in the interrelationship of environment and man. In the context of this topic all disciplines of traditional education converge. Some programs are now being developed in which the focus of each area of liberal arts and sciences is directed toward some aspect of human ecology. The entire curriculum at the University of Wisconsin at Green Bay is devoted to such a program.

At one time in the early development of the California State Colleges all schools were teacher training institutions. I propose that the focus of higher education in the State Colleges of California be reoriented to a consideration of human ecology from every aspect. Students would still receive degrees in English, History, Mathematics and teacher's credentials and premedical students would still be processed, but the unifying theme of all disciplines would be the survival of man. The emphasis would be on technology and function, with the fundamental concepts carefully built into the program as a block of core courses. The product of such a program would be not only an educated man but also an aware and functional personality.

We have little choice in this matter. The taxpayer and the parent will not long support a program that is geared to produce a new generation capable only of dealing with passé problems.

The '50's and '60's were years of explosive growth in higher education. The '70's may be the decade of the mass exodus of students from educational systems suffering from advanced rigor mortis. We must reorient our curriculum to encompass the great potential of our modern technology or face the collapse of the university from rejection by students en masse. There is no compulsory attendance law in college.

Science and Technology: The Question of Emphasis

John Hutcherson
California State College, Long Beach

Science and technology are the major factors which have shaped our way of life today. They are a part of society, and in a deeper sense, the knowledge and control of our environment which they promise must eventually become the province of everyone. Their impact on our lives has, however, been less by design then by circumstance. As a result of revolutionary changes in our technical abilities, the time is approaching, if not already at hand, when we *must* make some decisions about our manner of living. Education can greatly increase the possibility of our making successful choices.

The first role of education must surely be the development of a sense of responsibility. The increasingly tremendous power which science and technology give us cannot be wielded in a haphazard fashion. In the past thirty years, we have begun to see many examples of the results of our ignorance. The way we use our environment relates directly to the degree of knowledge we have regarding the consequences.

The rejuvenation of life support systems – and the development of new ones in the environment – is of course a technical activity for highly skilled specialists, but the execution of such tasks awaits the stimulus of political and administrative leaders who are able to make good decisions to promote the public welfare. And these in their turn depend on a public which is aware of its own best interests and able to support those who would promote it wisely.

In the preparation of these three groups: the skilled technologist, the intelligent leader, and the aware public, higher education has a clear duty. Traditional academic studies should continue to develop perspective and judgment for responsible choice. Science and technology, on the other hand, must meet these three groups differently.

The great public need is for knowledge in an area which is felt to be highly technical. Among the general college population, the traditional short courses in the natural sciences can serve well, but considerable care must be taken to assure that these courses relate to the real world at a level which provides useful factual knowledge. Additional encouragement is needed to assure that a much larger fraction of the students will benefit from these courses.

In the development of knowledgeable leadership, it would seem that a series of interdisciplinary degree programs are needed between science and technology departments and humanities and business departments. It should not be difficult for a student to acquire an intermediate level specialization in almost any pair of disciplines at a given college. Traditionally, we have encouraged broad development through the major and minor specializations in degree programs. This was a good plan and it should be revitalized and broadened to serve the new need. Especially important is the need to transmit the new responsibility to the schools.

The preparation of professional scientists and technicians is already a well-developed program in higher education. It produces talent which discovers new uses for our resources. It needs, however, to develop a stronger sense of responsibility toward the environment and give attention to its continual repair. The academic areas involved in environmental studies need to attract the professional scientist and technologist into elective courses, or if the need is great, even required courses, which develop the appropriate knowledge.

In the theme of this workshop, there is an urgency about all this. We can't wait another thirty years.

The Role of Basic Science

Kenneth E. Maxwell
California State College, Long Beach

The first thing that I should do is answer the question, "What are you talking about when you say 'basic science'?" The easiest way to answer is to say that basic science is the opposite of applied science. But like a lot of easy answers, it is not very precise. Basic science and applied science are like tallness and shortness, fatness and leanness or modesty and nudity. One extreme of the spectrum fades imperceptibly into the other – often agreeably, always elusively and sometimes coexisting simultaneously in the same framework.

A classic example is the comment of Michael Faraday. It is said that while Faraday was demonstrating his basic discovery of electromagnetic induction to a member of Parliament, the very important person asked him what it was good for. Faraday said, "Someday, sir, you will collect taxes on it." When Benjamin Franklin was asked about the value of a new discovery he merely answered, "What is the use of a newborn baby?"

One thing is clear. Basic science is not static but, instead, is dynamic and ever-expanding. In the time of Aristotle, when science was philosophy, basic science was that which could be observed with the naked eye. Later in the development of science, in the early days of microscopy, the basic unit of life was the cell. With refinements in optics and the discovery of the electron microscope, scientists revealed that the cell is made up of much smaller units. Then the biochemist discovered that the cellular components are made up of atoms and molecules, and that "life is chemistry." But the physicist pulled the rug from under this comfortable concept with the disquieting knowledge that the atomic nucleus itself is made up of smaller units. There are at least 30 or 40 subatomic particles and no one knows how many will eventually be discovered. The fact is that we do not yet know the ultimate unit of nature or of life.

It is possible to depart from basic science in either of two directions. One departure is toward applied science, generally called technology, engineering or by the haughty expression "mission-oriented science." I have no quarrel with the applied scientists. Their success in the long run is determined by the degree to which they master the basic sciences. The other point of departure from science is toward no science at all.

There are many people today, previously oblivious to science, if not disdainful of it, who are suddenly and sincerely interested in the effects of science and technology on the environment. Some of them merely complain. Maybe they are the ones who took Mark Twain's advice seriously, "Never learn to do anything. If you don't learn, you'll always find someone else to do it for you."

The greatest need for emphasis on basic science may be in general education. I doubt that courses in "pollution appreciation" will prepare businessmen, politicians and public officials for making wise decisions about the environment without the backup of hard-nosed science. When the principal preoccupation of men was tribal warfare, everyone from the chief on down had to learn and practice the way of life. Today, we live in a world of science and technology. I wonder whether we have lost some of the early intelligence or whether we fail to recognize that life has changed in recent years and whether we still tend to fight the curricular battles of the romantic period.

We probably face our greatest challenge from science itself. I speak of the pretension that because certain knowledge is basic, it is therefore good. The criterion for good science is not whether it is *basic* but whether it is *important*. Each particle of knowledge is important to different people and for different purposes. Our task is to separate the important from the trivial. The knowledge explosion has resulted in the accretion of a gargantuan burden of knowledge superimposed on what was the last word a generation ago. Admittedly, each teacher's specialty is an indispensable part of every student's education. But to put the imprint of every Ph.D. thesis on a student is to kill him with kindness and to suffocate him in the profusion of what, for his purposes, may be trivial knowledge.

Science education has not yet, it seems to me, faced up to the knowledge explosion. Understanding nature requires that we become broadly knowledgeable of the laws of nature, whereas the educational process for producing professional competence demands that we learn progressively more and more about less and less. Ortega y Gasset in his *Revolt of the Masses* says, "The specialist . . . is not learned, for he is formally ignorant of all that does not enter into his specialty." The time may have passed when anyone but a few geniuses can be highly competent as specialists and good generalists as well. Certainly it is true in medicine; it is probably true in environmental science. The obvious answer is that we must have scientists of many kinds just as medicine requires physicians of many specialties and many kinds of capabilities.

In science it would be easy to fall for the delusion that a good generalist is merely a scientist who failed to become a specialist. Unless the generalist receives a full dose of the basic sciences, now at least ten times richer than a generation ago, we may find that we are producing not a new kind of scientist but a new kind of dilettante – the come-easy scientist. A graduate must not only *talk* science but also be able to *think* science and *do* science. The curriculum therefore must be the vehicle not merely for students to acquire knowledge but also to gain an understanding of the natural laws of the universe and of man's environment. Let us provide flexibility, even complete freedom in the selection of courses by the student if he so chooses. But let us not dignify our guests at the scientific smorgasbord with a degree in science unless they are hungry enough to devour the entree. Science and technology of the future will make greater demands on scientists than ever before. No one contemplates returning society to the ox-cart stage of civilization. You might as well try to stuff the eagle back into the egg. Correcting the abuses of science and technology will require infinitely more sophisticated technology than heretofore known.

Because science and technology have produced unbelievable things, a popular sport today is to predict incredible accomplishments. This entertaining form of popular science is prevalent in all news media.

The human element, formerly important only in business and politics, is now a major force in science and the public attitude towards it. Because most scientists are restricted in perspective by the shackles of their specialties, most of natural science is incomprehensible even to scientists. Then how can science students – the scientists of the future – learn to distinguish fact from fancy, progress from preliminary results and conclusive evidence from point of view? There is no pat answer, but one thing I believe. There can be no depth of understanding without basic knowledge. Despite the temptation to bypass basic science for the expediency of the quick answer, only with understanding of the laws of nature can scientists avoid self-derogatory quarrels and contribute effectively to the orderly advance of science and technology.

There are conflicting views about the relative value of basic science and "how to" instruction. It seems to me that the distinction is artificial. Beginning courses in science, almost without exception, involve laboratory instruction. The manipulation of molecules and mice can be just as basic to the development of ideas in science as the manipulation of numbers or words, depending on whether the subject matter is important or trivial. Electronic devices have replaced the magnifying glass as the sixth sense of science. What was basic yesterday may have become absorbed in the humdrum practicality of the workaday world of today.

Our concern with environmental quality has to do with its effect on life. It seems, therefore, that an important part of basic science would be knowledge about the effect of pollutants on the living processes. Many people complain that science is being used with bad results. The significant thing, it seems to me, is that the purpose in nearly all cases is beneficial and that the deleterious side effects are unintentional. The bad effects exist not because of science but because of ignorance. If more people were knowledgeable about the toxicology of lead it would quickly become a minor problem. If more people understood the cellular effects of mercury, it probably would never have become a problem. If more people know the physiological properties of carbon monoxide, nitrogen oxides and peroxyacetyl nitrate, we would not be working toward 1975 and 1980 goals, we would, in my opinion, be achieving those goals in 1970 and 1971. Unfortunately, students have to learn most of the basic facts about those things outside the classroom, in the present state of our curriculum. Three years ago, we decided at my campus, to make a move in the direction of correcting that deficiency. We now offer an upper-division course entitled "General Toxicology" which deals with a new dimension in ecology – natural and extraneous substances in the environment and their effects on cellular and other living processes.

Should we examine the curriculum in new perspective, asking the question, "Are we encouraging the student to by-pass basic subject matter too soon?" Does he end up by knowing how, but not why? Will he be able to solve yesterday's problems but not tomorrow's? In short, are we in danger of educating a generation of graduates who can talk about science but cannot work at it? Are we leading the student down the garden path of self-delusion with the hallucinatory dream of a Utopian escape called "instant science for instant problems?" Unfortunately, we do not know what kind of world we will be living in 10 or 20 years from now. It is not possible to teach students to solve the problems of 1985 because we do not know what those problems are going to be. We can only teach them to solve the problems of all time, any time.

Rene Dubos, a practical scientist, spoke of those who expressed doubts as to the ultimate value of the natural sciences and impatience at the fact that science had not resolved the riddle of human nature and human destiny. Dubos said, "Far more dangerous . . . are the expressions of contempt for science as an intellectual discipline, and for scientists as thinkers."[1]

I believe that Dubos would agree that public faith in science and in scientists will follow in direct proportion to the emphasis which we place on basic science as the starting point for problem solving.

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[1] Dubos, Rene, "Scientists and Public," *Science* 133:1207-11. 1961.

III. SCIENCE AND HUMANITIES: THEIR INTERRELATIONSHIPS

We need better educated leaders and followers, more broadminded technologists, and more enlightened public school teachers. We need more people who have enrolled in environmental studies. The humanities students need more tough science. The science students need more hard humanities. A common study of ecological balances can help reintegrate Snow's two cultures, the twin products of the Renaissance, the axes of the central great tradition of modern civilization.

— Richard G. Lillard

*There are very few professors actually trained or educated in an interdisciplinary study. * * * Superficial multiple interests do not make a good teacher; nor do they bring credit to interdisciplinary studies. There can be little integration of concepts at sub-competent levels of understanding. We want all of our State College teachers to be the best educated professors available in the field, but faculty members should not be prohibited from increasing their breadth, growing in their interests and changing from one field to another.*

— Byron C. Kluss

If I were to have typed out a long manuscript to be included with others in this publication, it would have taken up so much paper, and have destroyed so many more trees, that the remarks I made in my talk would have been undone or made hypocritical. What are you doing to save a tree? To recycle glass? To reduce the human population? To make ecology more interdisciplinary? To increase communication among people? To increase interpersonal relationships? To grow and learn more about yourself as the world gets more complex? To enjoy your world and yourself more? If the answers to any of the above is nothing, then I don't think you can do anything constructive about ecologically related curricular changes or developments!

— Bayard H. Brattstrom

The balance between the humanities and the sciences in developing curricula related to the study of the environment was considered by another panel. The papers of two of the panelists raised some important issues and questions. (The presentation of the third panelist, Dr. Brattstrom, was not based upon a prepared paper and is therefore not included herein.)

The Common Ground of the Sciences and the Humanities

Richard G. Lillard
California State College, Los Angeles

In 1959 Charles P. Snow told a British audience at Cambridge University that "the intellectual life of the whole of western society is increasingly being split into two polar groups" – the scientific and the literary. Between the two he found "a gulf of mutual incomprehension – sometimes. . . hostility and dislike, but most of all lack of understanding. They have a curious distorted image of each other." He said that scientists are optimistic about the social condition though not about the prospects for individuals. Scientists, he said, are all right on moral values but weak in psychological or imaginative understanding. The literary intellectuals, in contrast, hold to traditional culture and are proud to be ignorant of the great edifice of modern physics.

In 1963 Snow admitted that his remarks better fitted Britain than America, and I think he did well to concede this, for I have not found the gulf, the polarization, that he announced. The most extreme theoretical researches into physics and chemistry, even in genetics, are seemingly far from the most extreme theoretical researches in linguistics and post-Aristotelian logic, but in between is a vast central mass of studies, scientific and humane, held together by colleges and schools of letters and science, by general education requirements in the lower division, by discussions at table in faculty lunchrooms, and reported in the science and arts columns of daily newspapers, weekly magazines, and the pages of serious monthlies, quarterlies, and books.

The Renaissance was a revolution in the humanities. Out of it, incarnated in Leonardo and Francis Bacon, came the revolution in the solid physical sciences – with the Royal Academy and Isaac Newton, the Academy of Science and Lavoisier – together with the whole neoclassical period of the Enlightenment. Then together with the romantic movement in literature, beginning in the late eighteenth century, came the rise of the biological sciences, incarnated in Darwin or Asa Gray. Sciences are human inventions, branches of philosophy. Like religious or literary movements, sciences respond to contemporary human needs, and they have their rise, their triumphant period, and their decline.

Though I don't see Snow's gulf, there is a gulf, as I view things, that does divide our civilization. On one side are the natural sciences, mathematics, the humanities, including history, and the several social studies, generally called sciences, such as sociology, anthropology, and cultural geography. All these are united by moral, esthetic, and philosophical concerns. They all ask basic questions. What are the verifiable facts? What is real? How do we know what we know? What is the truth – true from what point of view? Loving knowledge (philo-sophical) the sciences and humanities seek insight, comprehension, and the relationships of parts to entireties. They have in common the great tradition of rational inquiry as an end in itself and as a means to the general good. *Pure* science, *fine* arts, *liberal* studies – the adjectives connote approving judgment. Mathematicians seek *elegant* solutions just as writers seek the right word.

On the other side of the gulf are the vocationally-minded, paycheck-oriented persons, including all too many teachers, lawyers, doctors, and preachers, together with those whose one object is to win at all costs. This miscellany of the population includes engineers, technologists, merchants and manufacturers, politicans, military personnel, athletic coaches, profiteers, advertising men, salesmen, functionaries in public and private bureaucracies, and assorted commercial vulgarians from the highest topless to the lowest underworld. Again the adjectives are telltale, as in *hard-headed* businessman, *no-nonsense* administrator, and *practical* politician.

Roughly the issue is that of the college students versus the hard hats, the professors' academic freedom versus the demagogues' propaganda, or ideas versus dollars.

The difference is clear in the divergent destinies of two words made from the Greek word *oikos* or *eco*, meaning house. One is a new word, *ecology*. The other is an old word, *economics*.

Ecology connotes an emphasis on the living, the biological, on the financial impractical, perhaps, on the tender-hearted, the democratic, the all-embracing, the idealistic, even. All natural things have their roles, their place, their values. In nature as in human love, nothing is for sale. The pattern is to live and let live, to control other species and one's own species but to give all species free living space – to value the goose, whether it lays golden eggs or not, and keep it alive, along with the golden eagle, the trumpeter swan, and the whooping crane. The house in ecology is a general open house, a world house in which all species are welcome to try living out their destinies – and not in Noah's arks or zoos or fenced-in parks but in natural settings where they can be natural.

All the ideas and words related to ecology suggest accommodation to circumstances and mutual adjustment: ecobiotic, ecogeography, synecology (keeping house together), or autecology (interrelationships among individual organisms or individual species and the environment, including symbiosis and parasitism, too). Ecology connotes recycling, letting go to waste, opposing the *elan vital* to entropy.

Economics involves housekeeping management, keeping store, the handsome unearned increment, percentage of gain, the showy fortune, the gilt-edged security, the exploitation of men and nature. It means killing the goose to get the golden egg. It means emphasis on the acquisitive, the exclusive, the hard-hearted, the non-social. All things have their price. Natural resources are expendable. All other creatures must give way to man, and most men must give way to some men. At his best, a man takes possession and owns things. Indeed, the god of the Bible gave some men imperial command over nature for pleasure, comfort, and profit. Economics means the private estate or club, locked, guarded, the curtains drawn. In its extreme form economics leads to the windowless interior office, the bank vault, or a fortress above ground and under it a cavern packed with bullion. It leads to waste and to political war – carefully planned, lavishly destructive for all, though immensely profitable to some. Modern industry is based largely on a one-time use of materials, places, and persons.

For the economic mind the functions of animals are to produce labor or goods or food to be shot for sport, to be owned for prestige, and to perform an entertainment in zoos and circuses. "Economic man" loves a thing only during its "economic life" – when it is profitable. He does not mind if what he calls "progress" wipes out a human nation or culture, obliterates an ecological niche, exterminates a species, or jeopardizes the biomass. "You can't stop progress," he says. He uses "economic poisons." He assumes that men are in essence egoistic, possessive, competitive to the point of war and genocide, and properly myopic in their outlook toward the future. He assumes that men want to be independent of nature, that they can conquer nature, and that they welcome all machinery and all short cuts that lead to the great ends: power and profit.

In a world split between the learned and the pragmatic it follows that bread-and-butter education – the dominant tendency in American colleges – is not enough; but neither would idealistic education be enough – not in our practical society faced by immediate problems.

Scientific education is not enough; neither is humanistic. Looking back we admire men like Thomas Jefferson or Thomas Huxley, men who combined the practical and the theoretical, the scientific and the humane, and we are likely to say that things are too complicated to hope for the existence now of such men. In this we err. In the recent past Einstein, Zinsser, and Oppenheimer are examples. Sir Charles Snow is a living example, as is Julian Huxley. So to a most notable degree is Lewis Mumford, one of the prime intellectual influences in America since the 1920's, in such works as *Technics and Civilization*, *The Culture of Cities*, *The City in History*, and *The Myth of the Machine: Technics and Human Development*.

The problem of turning out well-rounded college graduates, as we know the problem in California colleges and universities, is compounded by pressures: the ever-expanding mass of new knowledge; the vast new half-prepared student bodies; the development of superficial science and literary courses to help ill-trained students meet requirements; the reluctance of governments and voters to spend money on education as they spend it on war, highways, and luxuries; the rise of vocational education to an obsessive concern; and a haunting, dark despair that everything is going to pot and no one can really do anything or raise any viable hope for mankind.

Despite these pressures that have the effect of diluting efforts and watering down standards and engendering contempt for excellence, we need better educated leaders and followers, more broad-minded technologists, and more enlightened public school teachers. We need more people who have enrolled in environmental studies. The humanities students need more tough science. The science students need more hard humanities. A common study of ecological balances can help reintegrate Snow's two cultures, the twin products of the Renaissance, the axes of the central great tradition of modern civilization.

We should plan accordingly. The general education of the lower division needs to require solid courses in anthropology, biology, English, geography, microbiology, philosophy, physics, and sociology – and, I should like to think, foreign languages. Majors intending to go into fish and wildlife work or pollution control need to take the basic courses in chemistry, and all underclassmen need to take some economics to see how the thinking goes on the far side of the gulf – a gulf that needs to be spanned.

A required core curriculum in the upper division needs to include more anthropology, biology, botany, geography, and also ethics and work in masterpieces of literature. Essential is a good course in statistics. Upper-division options leading toward conservation, planning, public recreation, teaching, urban leadership, forestry, or whatever would demand enough additional work that the student would end up with a tight course of four years or more.

Ideally, to assist in this renovation of the curriculum, the schools and departments of the college should vary standard courses or devise new ones, to the benefit of students and professors alike. Ethics, for instance, should become History of Ethics. Philosophy of Science should be broken into Philosophy of Biological Sciences, Philosophy of Physical Sciences, and Philosophy of Social Sciences. History of the Westward Movement should balance the alleged triumph of the American pioneer with a new look at his unbroken record of destruction and extermination. English should offer a course on the great nature books, which includes some of the great travel books. Botany should offer Fire Ecology; Geography, Marine Geography; some department, Biogeography (with ethology). Engineering should offer a solid, frank course on the impact of engineering activities on the natural and the man-made environment, and another course on the recycling of waste metals, glass, water, sewage, garbage, and air. Accounting should teach how to keep books on the costs of pollution and desecration and of materials once thought of as free, like water and air. Economics should improve on Siegfried Von Ciriacy-Wantrup's stodgy book, *Conservation and Natural Resources: An Inquiry into Economic Theory & Public Policy.*

Already the interdisciplinary approach, the sense of common responsibility, shows on California State College campuses and on other campuses from the California Current to the Gulf Stream. At Antioch College, a geology professor gives "The Dynamic Earth," emphasizing the continuing evolution of the earth under natural and man-made influences. At U.C. Berkeley, a professor teaches landscape architecture by covering the ecological sciences, with attention to environmental psychology and the sociology of open space. At U.C. Irvine, a professor of organismic biology teaches "The Vital Revolution," which looks at the population crisis from many viewpoints. A professor of natural science at Michigan State University gives science and human values, a study of the moral dilemma of the scientist and of contemporary problems resulting from advances in science. A University of Wisconsin professor in meteorology teaches "The Atmospheric Environment of Man," which deals with man as an inhabitant of the ocean of air. Yale offers "The Physics of the Environment." The University of Minnesota offers three undergraduate "programs": "Introduction to Ecology," "Ecology and Man," and "Ecology – the Final Crisis." A physics professor at City University of New York teaches "Science and Society," and Columbia University runs a five-year training program in Ecological Anthropology that leads to the Ph.D. At Princeton, a man in the School of Public and International Affairs gives work in the policy aspects of human ecology. A Public Health professor at the University of Massachusetts teaches "The Ecosystem under Stress," and Stanford, with a big boost from the Ford Foundation, is under way with its Program in Human Biology, a pioneering fusion of biology, medicine, and behavioral sciences.

The civilizing riches of the humanities have long been with us. For just as long, the commercial, anti-biome propensities of economics have existed. For the first three centuries of the scientific revolution physics has been the master science, along with its associate, chemistry, and their applied science assistants. Now some say that physics is losing its scientific momentum as it toys with lethal bombs and lunar hardware and that a new revolutionary, constructive science is rising to dominance – ecology. The other biological sciences and the humanities and arts, always oriented to life, can rally around ecology in all of its organic implications, as they never could around physics, for all its impersonal energy.

With good fortune then, to paraphrase Sir Charles, we can educate a large proportion of our better and more responsive minds so that they are not just matter-minded or man-minded but are imaginatively aware in the arts and in the sciences of our everlasting responsibility to our total physical setting and to our fellow species, as to our fellow human beings. We can preach and live by the Land Ethic. Thanks to science and technology we human beings are now, day-in and day-out, from the stratosphere to the sea bottom, the leading destructive force on the globe for hydrological change, for modification of earth's surface, for biological change – for ecological alteration. The hope for wisdom in facing this responsibility lies not in politics as such, or business and finance, or in technology – that opener of Pandora's boxes. The hope for wisdom lies jointly in the humanities and arts, the social studies, and the biological sciences. The proper study of mankind is man's modest place in the processes of nature.

Interdisciplinarity – Environmental Studies and Humanities

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Dr. Lillard has discussed the importance of including humanities in an environmental science program. I agree that it is very important. I believe that it is just as important to be aware of the possible ethical, political and sociological consequences of alternative solutions to environmental problems as it is to understand the environment. Man must know the price he will have to pay for solving these problems. The ultimate solution of the population problem, for example, may be at the expense of individual freedom. Do we want mosquitoes and malaria and the concomitant suffering and misery or do we want DDT and their insecticides killing the mosquitoes, ridding us of the malaria, but also polluting our rivers and killing birds. The point I am simply trying to make is that environmental studies must be more than a study of ecology. It must also include a study of the interrelated areas of economics, political science, sociology, philosophy, history, literature and the like. Raymond Bowers, Deputy Director of The Cornell University Interdisciplinary Program on Science, Technology, and Society, wrote in the November-December 1970 *American Scientist*:

> ***"Some young people have such a distorted view of the interaction of science, technology, and society that it is almost impossible to have a rational discussion with them on the nature of the scientific enterprise. If one loses all objectivity and sees a power station only as a source of pollution and never in terms of its production of electric power, if one views nuclear physics only as the source of the atomic bomb and never the source of atomic power for peaceful uses or as one of man's great intellectual achievements, then meaningful discussion of these problems becomes impossible. This is why I am working to introduce at Cornell, undergraduate courses and seminars on the interaction of technology [science] with society."***

Even though we might all agree that interdisciplinary studies are to be encouraged, there are real practical problems in getting people from the humanities and arts to work together with people from the sciences. I have had experience with such liaison since 1962 through work in a General Honors Program and more recently in an Urban Studies Program and several other special programs. I would like to discuss with you where such possible difficulties lie.

First, one often receives the impression that the general personality of the individual who goes into science is somewhat different from that of the individual who goes into the humanities. Men of science tend to be pragmatic, single-minded and strongly committed to a specific discipline. Among scientists there seem to be two groups: those who are eager and willing to work in interdisciplinary studies and those who are not. The groups are unevenly balanced; the latter group is the larger. The Biology Department at CSCLB has approximately forty-five members; only one member at present is willing to participate in an interdisciplinary course offered by the General Honors Programs. We have had other problems with this same course through the years: the humanists have wanted us to only talk about the significance and implications of science; the scientists, on the other hand, insist that they need first to discuss the "nitty-gritty" of science before an intelligent discussion of significance is possible. In General Honors physics, the humanists have asked for a discussion of physics eliminating all mathematics; the physicists say this is impossible and not desirable. These are not insurmountable difficulties. Reasonable, educated men eventually achieve an understanding, and a working arrangement can be agreed upon.

This brings up another point and that is the extraordinary amount of time spent by interdisciplinarians in committee meetings, in making these necessary and often complex arrangements. Time must also be spent in study and in learning about the new discipline. We ask more of faculty who go into interdisciplinary studies than we do of other faculty. Extra time should really be made available to them by reducing their teaching loads. If an individual achieves interdisciplinary competence at the expense of his original discipline, this deters interdisciplinarity and may ruin a career. Adequate fiscal support of interdisciplinarity is required. In our General Honors Program at CSCLB, now seven years old, only one faculty member has remained in the program the full period, and he was on sabbatical leave the 1966-67 academic year. Everyone who left Honors said something like, "It's too much work for what you get out of it." It is a lot easier and less time consuming to teach your own course in your own way without coordinating all your classroom activities with several other faculty members scattered over the campus. The current teaching load of our regular faculty is so heavy that I am continually amazed at the way dedicated teachers assume the additional burden of working in an interdisciplinary program. It is admirable, but it isn't right. The teaching faculty must receive adequate recognition and fiscal support of the time and effort spent in all interdisciplinary programs.

The vast majority of college professors are highly trained specialists in a specific discipline: biologists are trained as ethologists or cellular physiologists; historians are trained as specialists in medieval history. There are very few professors actually trained or educated in an interdisciplinary study. Therefore, when an interdisciplinary or interdepartmental program is set up, where do you find the faculty for it. Of course, you find them in departments throughout the campus – you find them in professors who are trained in one discipline but are now interested in studying or working in another. For example, we have on our campus urban studies specialists in many departments including the art and home economics departments as well as in geography, history, economics, engineering and political science. We have faculty in the philosophy, biology, English, and political science departments who are vitally and deeply concerned with environmental studies. This semester, the chairman of the philosophy department was scheduled to teach a special section in ethics entitled Values and Environment. Why does a person move from one specialty to another? Is it concern for mankind and a desire to help, an impatience with isolated individual work, a drive to reorganize knowledge to conform more closely with current needs of society, an intent to create new disciplines better adopted to social change, or an attempt to develop a humane alternative to ever increasing specialization? Increasing knowledge either leads to increased specialization and increased learning time or increased superficiality or new forms of interdisciplinary packages. This meeting, I presume, is to discuss this new kind of package.

It is only after several years of intensive study and hard work that a faculty member is able to make the shift from one field to another; and even though he has made the shift and is publishing in the new field, many of his campus colleagues will not recognize his new expertise. On our campus I have heard such remarks as, "Why is he, a European historian, studying the religions of India?" or, "We hired him as a geneticist and now he's studying ecology; why doesn't he get back to genetics where he belongs?" or, "He's in education; why does he continue to write papers on ground water?" What these remarks reflect is concern that faculty members are thoroughly trained and knowledgeable in the areas in which they are teaching. Superficial multiple interests do not make a good teacher; nor do they bring credit to interdisciplinary studies. There can be little integration of concepts at sub-competent levels of understanding. We want all of our State College teachers to be the best educated professors available in the field, but faculty members should not be prohibited from increasing their breadth, growing in their interests and changing from one field to another. It is possible. The goal of education has always been to turn out men and women who are capable of educating themselves.

When interdisciplinary programs are established and faculty retain their major assignments in "home" departments, the faculty member eventually becomes eligible for promotion. This may be a problem in that members of the "home" departmental promotion committee may feel that he: a) has left the department, b) is teaching out of his area of special competence, c) is working in an area they are not competent to evaluate, and d) his intellectual reputation is not established in this new field. It is much easier to evaluate someone who has made specialized contributions to a single discipline than to evaluate interdisciplinary contributions. For many, the standard of academic achievement is knowing a lot about some particular thing rather than knowing a little about a lot. Campuses need to be alert to such problems which arise when interdisciplinary programs are established.

Dr. Lillard has listed some colleges and universities where interdisciplinary courses in environmental studies are currently being offered. At CSCLB, in addition to the philosophy course – Introduction to Ethics: Values and Environment, there are three courses in the geology department – Environmental Geology, Air and Water Pollution, and Resources and Man. The latter course is to be team-taught in the spring semester by a geologist and an economist. Civil engineering offers courses in environmental engineering and engineering and civilization. The Honors Junior Colloquium is on the topic, "Experiments in Art and Technology". The biology department has a team-taught course for non-majors – Man and His Environment as well as Conservation of Natural Resources, Conservation, Biology and Human Affairs, General Ecology, Ecology of Marine Organisms, Field Biology and Ecology, Plant Ecology, Insects and Human Welfare, Insect Ecology, Ecology of Fishes, and Physiological Ecology. The Chemistry Department offers Chemistry and the Environment. The Microbiology Department offers Public Health and Pollution. The Sociology Department offers Human Ecology. The Physics Department offers Social Implications of Modern Physics. Many of the State College campuses have such a list, and better, I'm sure. One unusual aspect of some of these courses at CSCLB is that they are part of an experimental courses program, which is distinct from the experimental college also present on campus. The experimental courses program is designed to encourage educational innovation and experimentation. The College hopes by this program to permit a more flexible and rapid response to new situations, ideas and needs and to encourage new departures in methods of instruction, interdisciplinary learning, unit allocation, scheduling, faculty assignments and student-instructor relationships. Credit will be given for all experimental courses up to a total of 12 units. Experimental courses must be endorsed by departments and have the approval of the dean or curriculum committee of the appropriate school. Courses may be offered with experimental designations for a maximum of three years after which, on the basis of evaluation, they must either be dropped or proposed for incorporation in the regular curriculum of the College. We have found this experimental program to be a thoroughly satisfactory method of sponsoring curricular innovations.

One other point about CSCLB – the Associated Students have recently created an Ecology Board which is currently engaged in establishing an Ecology Information Center.

While talking about what is going on at college campuses, have you heard about the two-year-old University of Wisconsin campus at Green Bay? The University has been organized around the environment. Chancellor Edward W. Weidner says, "It is our aim to make every part of our program related to our ecological crises." There are no departmental majors; in fact, there are no departments. Instead, each student selects a particular environmental theme to study in depth. In addition, a student may, but is not required to, select an option in a traditional discipline. There has been more emphasis on disciplinary options than was originally anticipated. Many students have demanded it. They say that many employers don't have openings for an ecosystems analyst.

Most students need to be able to relate their skills to today's job markets. Can we do that in an environmental studies program? I don't know. Can we devise a curriculum in environmental studies that students will take and employers welcome? I don't know. I thought we came here to find that out. I do think that at Long Beach we have sufficient disciplines actively interested in environmental studies to put together a strong degree or certificate program. I agree with a statement in the October 19, 1970 issue of *Chemical and Engineering News* that each campus needs to go its own way, "building its own program tailored to the individual strengths and needs of the particular campus."

Administration of an interdisciplinary program like environmental studies may be difficult. If the cooperating faculty are from departments from several schools or divisions, the program director ought to report directly to the academic vice president, the dean of the college or their designees. If the participating faculty are from "home" departments, the simple task of making teaching assignments becomes complex and time-consuming. The teacher, the program director, the department chairman, the dean of the school and the academic vice president are all involved. In some cases department chairmen refuse to release their faculty to teach an interdisciplinary course. In these cases, the professor in question is usually teaching specialized courses in the department which no one else, including available part-timers, can handle. Departments can be uncooperative in other ways. They may refuse to hire new faculty who would be ideal for participating in a developing interdisciplinary program. "All right," you say, "why doesn't the special program hire on its own?" It might, if it had any positions, but in our current college climate of budget cuts and position freezes, where will the positions come from? Not from departments. They are already undersupported. On our campus the College Financial Affairs Council helps determine most position assignments and a new special program doesn't really have a chance with old, established, powerful departments clawing and fighting for the few positions we have recently been allocated. If environmental studies or any other special interdisciplinary program is really to flourish, it might best be supported with positions from the Chancellor's Office. Perhaps some change in the staffing formula might be devised for the support of interdisciplinary studies.

I cannot overemphasize my interest in and support of environmental studies in the curriculum of the State Colleges. "There is nothing so powerful as an idea whose time has come." Programs in environmental studies are needed. The latest *Population Bulletin* states, "Today the world faces a series of overlapping crises (in food consumption, environmental degradation, economic backwardness and excessive urbanization) which are all intensified by rapid population growth. . . . Virtually all of today's population education reformers – ecologists, conservationists, family planners, population experts – share the conviction that worldwide population growth and U.S. patterns of resource consumption and pollution have entered a critical stage, and that a major crisis will descend on us if we do not reverse the trends soon." I truly hope that this meeting will accelerate the reversal process.

IV. THE ROLE OF MULTIDISCIPLINARY AND MULTIUNIVERSITY PROGRAMS IN TODAY'S MULTIVERSITY

David L. Jameson
University of Houston

I propose to make the case that multidisciplinary programs offer an opportunity to examine questions not approachable by present methods. Let us define multidisciplinary programs as those which involve the totality of knowledge, in contrast to interdisciplinary programs which are designed to use the information in two or more disciplines to solve a single specified problem. Approaches which involve the use of the totality of knowledge require breadths of knowledge not available in a single department, nor a single interdisciplinary study, nor even in most universities. The assemblage of institutions represented in the conference are uniquely constituted to provide a multidisciplinary and multiuniversity approach to the complex problems confronting us today.

The Need for New Approaches

This is the season of ecology, one of those disciplines which has always prided itself on interdisciplinary approaches. Biologists typically use discipline-oriented, single-track sequential study and ecologists function in exactly the same way. Massive strides in the understanding of basic phenomena have been accomplished by the traditional single-track experimental approach which concentrates on one or a few variables. The geneticist has considered the variable genotype in a constant environment, the ecologist a variable external environment on a constant genotype, while the physiologist has emphasized the metabolic mechanisms involved in the relation between variable external and internal environments usually with a constant genotype. The changing phenotype in a constant external environment has been the subject of the developmentalist. These traditional specializations were necessary -- the spectacular breakthroughs of the molecular biologists demonstrate the power of the method, and success is probably a sufficient criterion for its continued, but not exclusive use where appropriate.

Ecology has its basic models, one of which is the predictive relation between the numbers of organisms at two different times,

$$N_t = N_o\, C.$$

The nature of the coefficient C in this equation allows us to vary fecundities, longevities, genotypes and to ask questions about ultimate productivity, immediate results, rates of change and stability.

The expansion of the system to examine the interrelation between internal and external environment and genotype is possible by using computers, massive experimental designs, lots of manpower and an abundance of luck. Multivariate analysis of variance techniques, successfully pioneered by agriculturists and exploited by psychologists and educationalists has demonstrated the effectiveness of allowing whole parts of the system to vary. Even so this is a specialized approach and involves the drawing together of presently separate sets of information and examining the intersect between two or at most a few parts. I suggest that these specialized approaches lead to naive considerations of the invariable components and more important, they lead to constricted visions of the whole system. The examination of the intersect implies that outside events have no significant relation to what is being measured. If outside events do influence the target system we are required to consider the whole set.

Systems analysis, which claims to examine the whole, is nevertheless based on the premise that any complex system can be partitioned into separate pieces. Presumably the sum of the separate pieces, adjusted by the interactions between the pieces will tell us all. Carried to an ultimate extreme we could claim that the sum of the atoms, properly adjusted will tell us all. This may be so but it is not necessarily the most profitable approach. Certainly the characteristics of carbon, nitrogen, hydrogen, oxygen and phosphorus do not sum to the gene and the characteristics of the gene are not studied merely by a detailed analysis of the elements. Additionally, most systems analyses deal with the management of one component or a limited set of components.

Parallel single-track analyses have left the ecologist with many unsolved problems. The relation between stability and diversity, the concept of competition, the identification of specific selective agents in specific evolving systems and the determination of the numbers of organisms are all ecological studies of less than conclusive analysis. Ecologists repeatedly talk of the balance of nature. However, will a perturbed nature return to some stable point? Who did that experiment? The claim is made that the "environment" is changing so the ecosystem cannot be expected to return to its previous condition because the stable point is moving. How is that stable point moving? – Random? Sine wave? Directional? Does the balance of nature really result in the determination of the numbers of individuals in the various species?

Attempts at holistic analysis have had variable success – or rather variable failures. The catch phrase "you cannot do any one thing!" exemplifies our dilemma. The statement emphasizes the study of one event as related to many others. Multivariate analyses and systems analyses are extensions of the same technique. I believe we are currently blocked by a methodological gap – the required "holistic approaches" are yet over the horizon.

Science, the so-called scientific method, and the structure of discipline-oriented organizations are designed to foster, almost demand, single-track sequential analysis. One approach to the scientific method identifies three levels of scientific activity: 1. classify and use facts, 2. achieve explanation, 3. critically examine. Most investigators are bright enough to classify facts, essentially the level of student activity, and most are capable of explaining a variety of complex facts because explanation is the realm of technician and engineer. The average investigator who attempts to examine critically the world he is working in will be asked by his department chairman to find another position because his productivity is too low or he will be asked by his regents to find another position because his examination is too critical.

Classification and explanation are necessary requisites to critical examination but scholarly activity should emphasize the latter; yet I insist, we have emphasized the classification and use of facts at the expense of both explanation and examination. Science today demands results measured in terms of papers, graduate students completed and money obtained. Modern science is very expensive and the individual investigator is forced to appeal to his colleagues, through the federal granting process, for sufficient funds to run his laboratory, and train his students. Failure to obtain federal grants results in failure to run the laboratory and in turn results in failure to publish which results in banishment. Indeed, the single-track problem solving approach has become an integral part of our established system, and new methodological approaches may require lowering the walls between disciplines or even reorganization of parts or all of the system. Parallel multiple-single-track analyses of a problem are not an appropriate substitute for the required holistic studies.

I am frequently asked questions by legislators with constituencies to protect. Most of these questions must be answered, "We do not know." I can often follow that we have never been given adequate resources to answer questions like that, that we have asked for such resources in the past, that we are repeating the requests now and that we will continue to do so. I sometimes reply that we have expended too much of our resources and talents fighting Nazis and Communists, or making moon shots or atom bombs or determining the fine structure of DNA, but the fact is, I expect we have spent a lot of time on activities we could have avoided had we tended to our fields a little more carefully.

I am reminded of the United States Biological Survey whose workers predicted the deterioration of the environment in many places, particularly as the result of the then prevalent agricultural practices. The survey no longer exists, having been phased out by an irate agriculturally-dominated Congress. Members of the industrially-dominated Congress and Legislature today often express the desire to phase out some of our universities. The development of new methods will require involvement in political processes and changes in academic attitudes. Let us examine how this can be accomplished.

Political Decisions

Retention of scholarly independence while resolving environmental problems suggests the dilemma of how to maintain independence of the body politic. Some administrators like to claim that academicians are not involved and that we should not become involved in the political decision-making process. Additionally, there is considerable debate on the means of involvement. Some of these are not realistic positions. Land grant colleges train technicians who, via extension services, do indeed advise the public how to run their day-to-day lives and business. Medical schools provide outpatient and public health services which inform major portions of the public how to live their lives and which influence legislative bodies in sanitation, pest control and health ordinances. Business schools, engineering colleges and law schools produce technicians and provide technical services that influence and determine the decision-making processes of our society. Yet, the academic freedom of the agricultural, engineering, medical, legal or business professor is hardly less than that of other academicians and indeed their scholarly independence is, and must be, just as protected. Clearly, the scholar is already involved in the political process, although his effectiveness is not always apparent or visible.

Before we can more effectively involve ourselves in political decision-making processes we need to understand more about the way the political process works. Political influence is exerted by means of lobby and interest groups, by harassment, demonstrations, and by voting systems, each with its own role and expected results and all probably necessary to our system. The legislator is often ahead of the public and, as an educator needs scientific help, so does he need the assistance of other parts of the society. The legislative process includes authorization, appropriation and administration, each step confounded by complex interactions of committees, staffs and public. The greatest weakness of the process is that inadequacy of any one part will essentially negate the whole. This is the source of a large amount of the pollution control failures. Adequate laws must be adequately financed and administered by agencies staffed with efficient and well-trained personnel. For success, the appropriate lobbying groups must function very efficiently.

Another source of policy failure lies with division of authority and responsibility. In Texas, the water agencies include the Water Development Board, the Water Quality Board and the Water Rights Board. The Water Development Board has the responsibility to plan for the future needs of the public. They lack the resources to obtain the expertise to produce a viable plan and they lack the authority to consider the necessary components to make any plan work (enforced recycling for example). They plan on the basis of an expanding economy and population, and on the transportation of water from the Mississippi River to West Texas. They ignore the failures of moving water in California and the wishes of those who live along the Mississippi. They have been stopped from funding by the use of emotional appeals to taxation and governmental control to prevent passage of bond issues. The Governor has recently stopped their planning pending more adequate legislative considerations.

The Water Quality Board deals with pollution and appears to be moving toward a reasonable recycle approach. The ability to deal with industry is hampered by the necessity to set enforcible and changing standards. When the amount of industry doubles, the allowable discharge of each industry must be halved to maintain the same quality of resource. Yet this board has no authority over the building permits for industry, has less than minimal staff, and until recently has had little if any control over the largest polluter, municipal sewerage. Great lobbying pressure from municipal and industrial agencies are used to prevent them from obtaining the needed laws.

In the meantime, back on the ranch, the agriculturally-dominated Water Rights Board has the power, the precedence, and the political clout to decide just how and where the water will be used and by whom.

The State Board of Barber Examiners is made up of barbers and vested groups to regulate the physicians, the lawyers, the insurance companies, the banks and the public utilities. There is one notable exception. Why is it that the educational programs are traditionally regulated by boards, many of the members of which are the least educated components of the community? Perhaps educators are negligent in assuming political responsibilities? Perhaps all regulatory boards need better representation by both the overeducated and the undereducated?

Educators must admit that *we are involved* in political processes and concern ourselves with giving appropriate answers. Some inappropriate answers are those which involve the direct expression of vested interests. When a demographer says there is no population problem, an economist insists on propounding continued unlimited growth, the editor of a farm journal calls the megalopolis irrational. the head of a national science organization insists on continued support for present research programs rather than shifting funds to new requirements, and, when an ecologist insists on nature's balance I have a tendency to squirm. Each of these has legitimate positions to propound without endangering those positions by such obvious artifact.

Ecologists need to avoid the credibility gaps of some other scientific groups. Considerable money has been spent on DNA research to find a cure for man's metabolic diseases, including cancer. Now, two decades later, only one clinically successful metabolic cure exists and Congress has been requested to establish a National Institute of Cancer with a $40 million budget. Bluewater oceanography has repeatedly sought funds from Congress on the excuse that the sea is the future source of food for expanding populations. The fact that the energy obtained in the open ocean is less than the energy required to harvest has been considerably played down.

An adequate and viable contribution to the political process can only be made by assuming positive viable positions based on workable environmental knowledge. There have been several successes and the positive components should be emphasized despite their many and often spectacular weaknesses. The air in Pittsburgh and London is certainly far better than a decade ago. The dust bowl and the Tennessee Valley are better places to live today than three decades ago because of the activity of the then equivalent of environmental scientists. Examine the recovery of the economies of Japan and Germany. We obviously need a Marshall Plan for the environment to recover from our own greed.

The Environmental Bank

How can political decisions about the environment be influenced? Society is essentially exploitative. A resource is discovered, energy expended to improve the ability to obtain that resource, and, when that is used up, we shift to a new resource. Only when there is no new resource or when the costs of shifting are intolerable is real effort expended to renew the resource. Resources are usable on a long-term basis only when they are available and when they are renewable. While land, air and water are obviously renewable, research suggests that all resources are renewable except for energy which is probably not limiting. The criterion for exploitation then becomes "improve the availability of the resources without destroying its renewability." Efforts which do not meet this criterion should be taxed to provide funds to support research to develop methods which do meet this criterion. The forest products and agricultural industries already realize the necessity for this approach though often they are unable to follow its tenets.

Man cannot continue to draw from nature's resources without making deposits. The failure of nature need not concern us as much as the failure of our relation to nature. Experience has shown that customers of banks fail more often than do banks and our society will fail, indeed deserves to fail, if we do not tend to the balance of resource payments.

How are questions about renewability asked? How is the long-term gain of renewability measured? How is the long-term loss of renewability taxed? How are the decision making processes influenced or changed? I claim single-track sequential analysis is not adequate to answer these questions; new methods are required.

Environmental Studies Programs

Universities are being polluted by Environmental Institutes, Studies, Programs and Plans. A variety of institutions are required because they will work differently in different places. These institutions will succeed in supporting the collection, classification and use of facts and a few will partially achieve explanation. The number which will critically examine is most indeterminant. Many will be formed as a source of attracting dollars; many will function merely to change internal power structures. Other programs are, or will be, paper institutes, paste-on affairs the main function of which will be to funnel money from the source to where the individual investigator or teacher is doing what was already being done with some other funding. Most of these programs will be the result of the energy of a few men and a concentrated idea, and that idea usually involves how to transfer money from there to here.

The University of Michigan has an Institute of Ecology supported by the Rockefeller Foundation. They support research and the addition of new faculty on a phase-out basis. The University of Michigan has met the challenge with the research-oriented program it is most capable of developing. Dartmouth College and Williams College have developed undergraduate curricula in environmental studies. These liberal arts colleges have attempted to develop their strengths and provide a balance between specialists and generalists. Numerous free universities are operated on the only possible basis, interest and expertise of the instructor and student. In the South more than twenty universities and research institutions have united to mass a multidisciplinary attack on the Gulf of Mexico. One university could not hope to approach the whole Gulf of Mexico but it can be studied by combining talents and forces.

Environmental studies are the big thing now and thus will attract workers because of a variety of forces. One young man in a department was told to get involved because his responsibility was to protect the interest of the department. He seriously considered resignation! Many will be attracted because of the personal financial reward or because that's where federal funding is available. We can easily predict that much that is done will be as useless as much of the studies that follow current scientific fads because the efficiency of most complex systems is low. Nevertheless, this background noise is probably necessary to reach the goals of a viable environment and a viable society. Certainly environmental study is where the action is, and many like to be in the middle of the game. One real danger is the number coming into environmental studies because they are concerned. They want to question without ever collecting facts or fighting their way through the process of achieving explanation. "Oh wow!" is not a substitute for hard work.

The internal and external forces which conspire to prevent critical examination of society are indeed prevalent in our academic and political institutions and the result will be, I am afraid, that most environmental studies programs will, like most research of any kind, "not amount to much." New structures, new approaches and new methodologies may be required and these can be obtained by multidisciplinary programs.

Multidisciplinary and Multiuniversity Programs

The goal of multidisciplinary and multiuniversity programs must be to solve problems which presumably cannot be solved in present structures. Research and instruction in many complex problems such as environment cannot be budgeted in present disciplinary units because the talent necessary to solve the problems are dispersed in more than one department and the territorial imperative of most administrative heads is a vast stumbling block. Multidisciplinary programs should provide a world in which new and creative things can happen. The greatest danger lies in the creation of a new structured and bounded activity with its own vested interests. The problem is to allow interaction without building new bounds.

There are some devices, the use of which can be explored. The student-teacher credit hours of faculty in an interdisciplinary course can revert to the unit that pays his salary. This is satisfactory if all units have the same source of support but will not solve problems which arise with the needed interaction between public and private institutions. Faculty can be appointed "at-large." They can function loosely within the present structure, serve for specific terms and have specific roles. While retreat to the appropriate department can be a problem, Berkeley and Michigan have followed this procedure. At-large students and programs offer great possibilities. One institution allows any two faculty members to establish a degree plan for a student. Undergraduate class projects in environmental reclamation have been proposed by some schools, and graduate projects and graduate term theses have been suggested. Continuing education projects involving industrial executives, governmental leaders and graduate students and faculty are in planning stages.

There are a number of essential requirements for successful multidisciplinary programs. The most important ingredients are creative administrators, faculty and students. Innovative and interested faculty should be able to develop programs within present structures and disciplines but they are often unable to do so. Despite the presence of innovative faculty, innovative multidisciplinary programs are relatively few, probably because internal restrictions exist and external stimulus may not be present. Independence and real program flexibility are absolute essentials and these appear to be most available in those institutions with great educational strengths such as Michigan and Berkeley.

The great necessity will be time. Professors who only talk about holistic approaches to multidisciplinary problems can hardly be expected to teach students to work at using these approaches. Time must be provided for teams to work together to develop new interactive methodologies. These teams must include large numbers of planners, engineers and individuals used to working in teams, but they also must include philosophers and some recalcitrant individualists. Time must be provided to develop communication, new ways of thinking, new methods of analysis, teaching and research.

There are not enough dollars to do this and new dollars are not immediately obvious. Therefore, we, those of us in the classroom, in the committee membership, the administrative leadership positions, must insist on the reallocation of the educational priorities to provide for interaction between and within departments and schools and between universities and private institutions. Some of these reallocations verge on the impossible in the presence of administrators possessed with massive territoriality and they are also impossible where basic educational decisions are made by business managers (often disguised as professors or as faculty committees) more interested in competition for full-time equivalents among the several university systems rather than the needs of society and of the students. The needs are too great for unnecessary duplication and the required resources are too varied for single-track approaches. Here is where multiuniversity interactions can allow significant consideration of the massive problems confronting us today.

Universities are both the storehouse and the developers of disciplinary knowledge. Certainly this is the responsibility of the great universities and the expansion of new programs at Harvard, Chicago or Stanford, or even at Cornell, Michigan and Berkeley may require the maintenance of strong, traditional disciplinary structures. Other universities may be able to better participate in the changing world by reorganization and reallocation of resources, goals and objectives. The changing needs of educational institutions must be met. We must first succeed in our own provinces before we can realize the reallocation of national priorities.

California State College System Mission

One of the mandates of the California State Colleges is for community service. The direct and reasonable expression of this mandate is the development of programs which include the equivalent of agricultural extension services. An extension service in environmental sciences is starting at the University of California at Davis and is under consideration at State University of New York at Buffalo, the University of Houston and others. The systemwide availability of diverse and creative talent, the already existing multiversity structure and the tradition of working together and with the U.C. system, and with the local, private educational and business structures provide a framework for immediate mobilization of efforts.

The California State College Environmental Extension Service should include the total system, all departments, all administrative units and should seek to develop new and creative holistic approaches to existing problems. The California State Colleges have prided themselves on instructional excellence. This excellence will be maintained in a rapidly changing world only by changes in academic attitudes. The students, the faculty, the administration and the system will be negligent in the assigned responsibilities to community service if they fail to respond to these challenges.

Summary

The traditional single-track problem-solving approach has been a powerful tool which has solved complex multidimensional problems and fostered disciplinary studies. This approach has resulted in naive considerations of the whole and has not encouraged the utilization of resources to answer the complex problems encountered in a modern society. The inherent weakness of the political process requires broadest contribution in the policy-making decisions. Positive viable positions based on workable environmental knowledge are needed. Multidisciplinary and multiuniversity programs can provide the talent and the resources for creative and new approaches to problem solving. Independence, authorization and allocation must be accompanied by considerable time for diversely trained scholars to develop new and interactive methodologies for analysis, teaching and research. The reorganization and reallocation of resources, goals and objectives will be required by most institutions and groups of institutions to meet the changing needs and to consider today's massive problems. The California State Colleges are uniquely equipped to meet the challenge by utilizing the whole system to provide new and creative approaches to community and statewide environmental problems.

Conclusion

In conclusion, new programs, including new ways of teaching courses, new research efforts and the development of new methodologies are required. Responsible participation in the political processes with positive and creative suggestions which can only be developed by the reorganization of large parts of all of most universities and university systems are necessary. The maximization of creativity and massive use of good sense must be provided.

Let us be aware – if we teach environmental studies we are both inside and outside the establishment. We cannot continue without criticizing ourselves and endangering our positions both from within and from the outside. However, this society must learn to live with the environmental bank or it will, indeed it deserves, to join the many other societies that have failed.

V. THE EMPLOYMENT ENVIRONMENT IN THE 1970's AND 1980's

Curriculum building cannot proceed without attention to anticipated employment opportunities for graduates. While the California State Colleges have an important mission in education in the liberal arts and sciences, they do, as well, have a major responsibility in offering four- and five-year occupational and technical programs. Members of a panel considered the needs of public schools, industry and government for persons with training in aspects of ecology and environmental science.

Public Schools – Charles K. Roberti, Humboldt State College

Why should a member of an education department on a State College campus talk about public school employment and environmental issues? Sometimes people refer to me as the instant ecologist. A faculty member of Humboldt State College for six years, it has taken me about this much time to become involved in an environmental or conservation college program. I sometimes think, when I look at you who represent mostly the sciences, that a member of an education department might be referred to as a new classification of endangered species.

If I assess the demand for public schools correctly, it would go something like this: In 1968 the California Legislature amended the *Education Code*. These Code changes mandated the public schools to teach an awareness of environment and use of natural resources in appropriate grades throughout the public schools. The State Department of Education is at this time implementing these provisions of the law.

Prior to the passing of this legislation, most environmental-oriented activities which took place in the school systems, primarily the elementary schools, were outdoor education programs and were basically not really environmental programs but outdoor recreation programs. In addition, in 1967 the State Legislature created a State Advisory Board for Conservation Education which is advisory to the State Board of Education and the State Department of Education. This board will be a clearinghouse for many ideas and for many of the federal funds as well as the State funds for public schools.

In public schools, primarily in the elementary grades, our teachers are required to teach some thirty-seven subjects by State law. They are so segmented and so isolated that I think it is appropriate to tie these together. The environment can be the focus because all of them are directed towards helping the person function better in their environment.

I am not overly concerned about the secondary program in the sciences as some of you may be. I am more concerned about the students in the creative arts or in the social science areas who do not have instructors who can relate the environment to these subjects and make them more meaningful.

I would like to present a few figures for perspective. The State of California has 7,074 public schools. The breakdown goes something like this: 5,606 elementary, 446 junior high, 746 secondary schools, 186 continuation high schools, 90 community colleges. As a teaching force we have something in the neighborhood of 187,092 elementary, high school and junior college instructors in the state. The bulk of those are elementary. Of the 187,000 in all levels of the public sector we have over 105,000 elementary school teachers in the State of California. With anticipated surpluses in teachers in the years ahead, our problem is not gross numbers. To assess the supply of teachers for environmental programs in the public sector is somewhat difficult. I would say less than 5% of all of our elementary schools have any kind of environmental curriculum. In the secondary schools we have some good science programs. What kind of teacher training do we have? How many of your teacher training programs offer environmental courses in their curricula? How many of you have strong in-service programs in environmental education?

To teach in conservation environmental education, there are no existing credential requirements. The licensing law of 1970, the Ryan Bill, gives each and every one of you, whether you are in science, natural resources or some other phase of the campus a golden opportunity as I see it. We have three years to work out new credentials for the State of California. No longer will there be a differentiation between elementary and secondary credentials; it will be one credential. It must be multidiscipline in nature. As a member of an education department, I am quite aware of the division between the education department and "science people who are worrying about other people supervising science students." I like to refer to this as mutual disrespect. I think the licensing law of 1970 is something that may bring us together if we use it properly.

I am concerned that we do not have enough in-service programs. This summer Humboldt State College is having a teacher training environmental institute. The institute is for elementary and junior high teachers. This course is being cooperatively participated in by the School of Behavioral Social Sciences, the School of Science, and the School of Natural Resources. One last concern I have is that someone will come up with the idea: let us have a specialist. Let us have someone go down there and teach those kids something on the environment between 2:00 and 3:00 o'clock. As soon as the specialist leaves the classroom, the teacher can go back to doing her thing and there will be no attempt to connect the some 30 plus curricular areas.

We need supervisors who will help the classroom teachers develop across the board programs. But specialists in the schools are not the answer.

In conclusion I would like to say then that we have a strong demand for teaching, we have a large supply of teachers, but the teachers are environmentally untrained. We need massive retraining of teachers, we need to upgrade, and to include in our preservice program, some course offerings that directly relate to the environment.

Public Schools – Rudolph J. H. Schafer, State Department of Education

I want to talk to you briefly about some of the things the Department of Education is doing in the field of environmental and conservation education. We are interested in a school program which is primarily problem-solving, decision-oriented. We are looking toward helping students make intelligent environmental decisions in regard to their own personal lives and activities, as well as with the decision-making process through which society affects the environment.

We see three major learning areas as being necessary to help people make intelligent decisions about environmental problems: First, students need to understand their environment. What is it? How does it operate? How are we interdependent with it? We also need to help students develop some favorable feeling toward the environment through the arts and humanities program. Second, students need to understand something about environmental technology – man's adaptive process to the environment. The third area that we feel is important is: how do individuals become involved in the decision-making process? This would include all of the social sciences as they relate to environmental matters.

In the 1970 legislative session, Assembly Bill 1050 and Senate Bill 948 were passed. I will briefly summarize the provisions of these bills. First, they provided us with more money with which to operate. The year before last the State Department budgeted $35,000 for educational programs in environmental education. This year we have $176,000, most of which is going in the form of grants to districts and several of the State Colleges. The bill also gave us a strong statement of legislative support for conservation education. We also have a much stronger statement in the curricular requirements. Section 8503 of the *Education Code* has been strengthened. The words "environment" and "ecology" are included in the science curricular requirements. We hope that the Legislature will extend the requirement into social science next year. The law also now requires that state textbooks adopted in grades one through eight reflect an emphasis on protection of environment. Also, we have an environmental internship program, which is authorized but not funded. Under the environmental internship program, it is now possible for educational institutions and management agencies to develop a work-learn program during the summer for high school students. Presently, about the only way for youngsters to work in this area now is to be sent to the Youth Authority. Unfortunately, the funds for the environmental internship program were removed from AB 1050 at the last minute, but, perhaps, we will have them next year.

One of my major responsibilities involves working with a citizens' advisory committee to the State Board of Education. I am trying to encourage and work with teacher training institutions as well. I conduct workshops at the county and local level. I am preparing and developing materials in environmental education including a framework for grades one through twelve. I work as a consultant with school districts, teachers, and county offices. I try to secure, in so far as possible, community participation and support for the conservation education program. I try to work with various groups that offer some expertise to the schools and who can help us. I also supply legislative information to the various members and staff of the Legislature, hopefully to secure legislation favorable to conservation education.

I am concerned with your efforts to provide the kinds of teacher training that we need. We must help our teachers see what they can do in their particular discipline to develop an awareness of and concern for the environment. I would be pleased to work with you on such teacher training efforts.

Industry – Henry Trobitz, Simpson Timber Company

One of the key things I have learned from our conversations so far is that your industry – I am going to call education a big business – and our industry, or industry generally, have a lot in common. We are both dealing in salable products. We both deal with renewable resources – I am talking about my own industry at the moment, which deals in growing trees, harvesting and producing forest products. Yours is youth, ours is young trees. Age of fruition is a little bit different. You deal with around 20 years I guess, we are out around 40 or 50 years. We are both part of multistructure organizations. you could call it bureaucracy. I say that they are both public dependent. I would say further, really both publicly owned.

We both have image problems. We may think that it is not of our own doing, but we do have image problems. The reason I know you have image problems is because I serve on the Advisory Board at Humboldt State College. We are the liaison between the community, the public and the college. We are the center for people to come and talk about what they think is wrong with the college. In my industry, and industry generally, we have image problems. Up to a few years ago I do not think we thought we had any image problem. Matter of fact, I do not think we knew what image was. Another common point is that both of our sales and our incomes are down. Our industries are, and after listening yesterday to discussion of the placement and the overproduction of teachers, so are yours.

I think that environmental problems may hopefully serve as a catalyst to bring these two disciplines – I am talking about industry and education – together to form a major force, hopefully to resolve our environmental needs. There have been some false barriers set up, I do not know whether they are professional jealousies; I do not know what they are, but I know they are there. We are going to need some expertise, hopefully in the training of your people so that we can get on with the problem of solving environmental needs. Unfortunately I do not think we really talk the same language. I refer in part to much of the research that we get from the university or college. I have written papers and was in research for the Forest Service for some years. Research papers seem to be as difficult and incomprehensible to the average person as is possible. We have some semantic barriers here.

As far as environmental problems are concerned, I think there is room for an immediate program. When I attended the Governor's Conference a year ago, I felt that many of the participants believed there was some kind of a gimmick to correct all of the environmental problems. They were asking for research money, and properly so, but no one was talking about what you and I can do right now about helping the environmental problems. What can we do, for instance, about self-discipline and constraint? Are we really genuinely interested in doing something about environment? In our own operation we are going back to the woods. We have not done as good a job in the past as we might have. We have left equipment out there and we have not done a good job of cleaning up. We have not done a good job in the drainage on our roads. We are going back and doing it. The first thing we must do, is not to create any more problems. Then we must go back methodically and clean up the mistakes of the past. This step-by-step approach is not going to require a large amount of money to start with.

Listening yesterday I notice we brushed over rather lightly the economic aspects of our environmental problems. We are quick to say, boy we have made a mess of things. We are not so quick to say that we have enjoyed the fruits of it. And we have.

As I assess the environmental goals that we must set, the real name of the game is to improve our environment without destroying some of the other programs that we feel are important too. And number one is education.

What kind of people do we need in our industries, the forest products industry in particular? We like to have people with backgrounds in science, natural resources, physical sciences, life sciences, engineering, and business administration. We find that this group, regardless of their basic discipline, seems to bring to us the breadth that we can build upon to give us flexibility and movement. We feel that rather than having ecologists, our needs lie more in people with backgrounds, for example, in economics, and communications. I want to take a moment to allude to the communications aspect from the standpoint of being able to talk. All of us are salesmen. You are salesmen. If we are not salesmen, we are not going to accomplish what we hope to. So this matter of being able to communicate is most important. We also want people who come to us to be oriented toward industry with its profit motive.

I am wondering too if the trends do not indicate that there should be more emphasis placed on the vocational disciplines. We have a great need for more skilled people trained in maintenance and in electrical areas. All of our equipment is much more sophisticated than it was. I think there is a need for trained technicians, but I don't know how we are going to direct people that way.

We are interested in having an opportunity to develop a dialogue with you on what kind of people we would like to have. You are going to have to improve your sales record if what I heard yesterday is any indication. In conclusion, it has been a pleasure to be here.

* * *

(Dr. William Garman, Vice President, Occidental Chemical Company, also presented the interests and concerns of industry. Unfortunately, his remarks were lost due to a malfunction of the tape equipment. In brief, Dr. Garman stressed the point that many industries were in fact today engaged in many efforts to improve the environment and reduce their potential for pollution.)

Government and Public Service – Stanley Stevenson, U.S. Forest Service

The Forest Services, as well as other federal, state, county and some municipalities, require many different disciplines in managing their lands and resources in a manner that is acceptable to most of the people. Since there is a similarity of employee needs, I will confine my comments to the United States Forest Service.

For many years the United States Forest Service actively recruited foresters to manage the 154 national forests in the national forest system. Civil engineers, business administration majors, and a fewer number of specialists in range and wildlife management, were employed to provide expertise we must utilize. The competition between user groups for use of national forest land requires a multidiscipline team approach to assure full consideration of all the factors affecting the land, the users, the resources, and the environment.

With the need established for input from many disciplines, as well as the public, in the planning process and in executing approved programs and plans, the question obviously is how many new employees and when.

As you know, we are in a period of economic adjustment that will reduce public expenditures at nearly all levels of government. The Forest Service is no exception, and our recruitment is reduced accordingly.

We will, however, need a few new people as new programs develop and as additional skills and knowledge are required. For instance, the Civilian Conservation Corps of the Job Corps required many new disciplines not found in the Forest Service previously: that is, teachers, youth counselors, medics and so forth. The new Youth Conservation Corps that is being initiated this year on a trial three-year basis for 3,000 youths will require similar disciplines.

Technicians in specific fields of engineering, timber sales, range management, soil surveys and analysis, fire control and business management will be needed.

During the short term period, i.e., next five years, the U.S. Forest Service in California will need 25 foresters per year, 50 forestry aids and technicians and from 35 to 50 professional grade people in all the other disciplines.

Nationwide our estimates are for some 1,300 new hires per year to include both professional and technical people. I might go down through the list and just indicate the breadth of the people we will be needing: administrative-management people, biological aides, entomologists, plant pathologists, the foresters, (they are the majority, and continue to be the bulk of the people that are new hires), soil scientists, accounting and budget analysts, landscape architects, civil, mechanical and electrical engineers, mining and industrial personnel. We will also need public information specialists, visitor information specialists, some realty assistants, and some skilled in geology and mapping.

Long-term needs, of course, are more difficult to predict. We anticipate hiring people with expertise in fields that are now only being developed and of course, technicians in these new fields to support the professionals.

We are particularly interested in the managerial ability of all of the professionals and many of the technicians, as they will be used to run the Service in the future. Although the prospects for employment of both professionals and technicians are presently at a low level, they will rise in the future, and we will continue to need about 1,200 to 1,300 people annually. Hopefully, and optimistically, some 2,500 per year will be needed in the 1980's.

Government and Public Service – Albert Bockian, State Air Resources Control Board

I will talk to you about what we feel are future employment opportunities with air pollution control agencies. We hire in basically four job categories. We hire chemists mostly for laboratory analysis and for research and development work. We hire physicists for research and development work and also for instrument design; there is a great deal of instrumentation that we need that does not now exist. (While I am talking about chemists and physicists I would like to bring up a point which you may think is trivial or peculiar but nevertheless is a real one. I have a doctorate in chemistry but my title is Supervising Physicist. I am a Supervising Physicist because, quite frankly, I am paid more with a physicist's title than with a chemist's title. This is one of the facts of life that you and your students must live with. I should also tell you that my remarks should be interpreted in light of my academic prejudice. I do not think that the major function of junior colleges, State Colleges or the universities is to turn out a product for industry. I think higher education's function is to turn out a well-developed person with a broad background, some specialization to enable him to make a contribution to society, and an awareness of the overall needs of society.)

To repeat, we hire chemists and we hire physicists. We also hire engineers. They do mostly source testing in local agencies like the County of Los Angeles – not so much in the State of California – though we are going to get more involved in this type of work because of legislation that has been passed on the statewide level. (Source testing means going to the source, whether it is a motor vehicle or a smoke stack, and testing what is coming out of that particular source.) And then finally, in a broad category, we hire business management/public information personnel. These people are not particularly science-oriented, and yet are able to pick up enough of a smattering of scientific knowledge to show somebody through a laboratory or through an engineering testing operation and discuss it at a reasonably intelligent level.

There are some laboratory analysts needed; these people are primarily chemists. There is some laboratory research and atmospheric research – the people who do this are primarily chemists and physicists. There are needs for instrument production and design, the people who do this are primarily physicists and electrical engineers, or electronically-oriented people. And then there is air monitoring, which is measurement of the air quality in specific locations. This is done under the guidance of an engineer, but the actual measurements are usually performed by a technician who has a high school or junior college education. Technicians also serve elsewhere; they are used in the laboratory to prepare solutions and conduct other routine operations that do not require the knowledge and expertise that a chemist possesses.

As a guess on my part, I see the overall job opportunities as follows: the Air Pollution Control District for the County of Los Angeles currently employs about 320 people to serve a population of 4,000,000. So if we extrapolate this for the state with a population of 20,000,000, it means that statewide we have employment possibilities for about 1,500 people. I would estimate that roughly 600 are currently in the field; this includes the Air Pollution Control District of Los Angeles, which is by far the largest employer, the Bay Area Air Pollution Control District, and the State of California Air Resources Board. There are several other air pollution control districts, such as Orange County, but they employ small numbers. We have about 600 people currently employed statewide, so with a 1,500 person potential, this leaves about 1,000 to be employed over the next decade. And roughly one-fifth of these, (based on what is happening currently, and what we foresee in terms of legislation) would be in source testing and about one-fifth in enforcement. About ten percent, I would say, would be chemists and physicists. This leaves almost half of the group, and these fall into a variety of disciplines – statisticians, meteorologists, computer people, business administration majors and then, of course, clerical assistants, technical assistants, air monitoring technicians, and similar categories.

Now the necessary academic disciplines, I think, are obvious from what I have said. Science and engineering are certainly required. But I think crossbreeding is important and one of the less obvious needs for crossbreeding and communication is between scientists and engineers. My boss is a mechanical engineer. (He was an English literature major before he became an engineer.) We get along very well personally, but engineers and scientists look at problems differently. This is why they are in their different disciplines. They conceptualize problems differently. And I have one heck of a time trying to get him to understand what I am trying to accomplish on a specific project, how it relates to what we are doing, and why it has to be done the way it is done. One very obvious difference, is in implementing the concept of a controlled experiment. A scientist sets up an experiment, varies one thing and says, in very simple terms, that any change in results is due to this one variable. In contrast, an engineer wants a system that does something. He does not build two bridges with one as a control – he builds one bridge. So I have a heck of a time with my boss because I may set up a control system and he may look at the experiment and see nothing happening. All the dials are zero. So he will start fooling around with the experimental parameters because he knows darn well that (from an engineer's viewpoint) something is supposed to be happening. I am pointing out that there is a real communication problem even between people whose disciplines are fairly closely related, such as science and technology. And of course this means that there is even a greater gap between people whose disciplines are not closely related, like scientists and engineers versus economists and business administrators. The scientists and engineers have to have some orientation about business administration, simply so they can understand the internal operations of the organization. They have to know something about economics so they can be aware of economic implications, because controls cost money. One has to be aware of politics, because much of what we do is the result of legislation. There is also the more practical type of politics which arises, for example, when you want to shut down a plant or enforce controls because of an obvious violation. We have one of these cases now in a small town in northern California and the people are up in arms. The company in question is a major employer in the town and the townspeople are afraid they will lose their source of livelihood. They have contacted their state senator and have sent a petition to the Air Resources Board with 2,800 signatures on it, saying they are supporting the operations of this plant. In this case, politics may affect technology and control strategy.

I think I would urge job versatility because I am not sure that there are really going to be a great many jobs in air pollution research and there is a danger of overspecialization. There is a danger, I think, even at the undergraduate level, and certainly at the graduate level, that a person may become so specialized that there are only three jobs in the country that he can fit into. If these jobs are filled, the specialist has had it. So I think I would urge you to give students a broad overview with specific training as a chemist or as an engineer or an economist, rather than try to point them to a particular job in air pollution.

How good is the job outlook? I really do not know. Right now there is an excess of engineers so new graduates have a problem. The American Chemical Society in some recent predictions said that there may be a surplus of chemists until the 1980's, so I really do not know whether in good faith I could advise people to go into chemistry and engineering at this time.

I have not said anything yet about the opportunity in federal laboratories. The National Air Pollution Control Administration has a very widespread national program in air pollution. Their laboratories are centered in North Carolina, and they employ a wide variety of scientists, including some previously unmentioned categories such as microscopists and microbiologists.

Finally, I would urge you to get up an advisory committee of people from various air pollution fields. These people may be from government or industry. When courses are being considered, at least invite them as guests so they may provide an orientation and expertise which may not be readily forthcoming from the particular training and disciplines which you have among your faculty members.

VI. WORKSHOPS IN CURRICULUM DEVELOPMENT

The papers, panels and group and individual discussions were directed primarily toward the establishment of initial guidelines and conclusions which may be applicable to curriculum and curriculum development at each of the California State Colleges. To give form to these curricular guidelines and conclusions, the participants were organized into four workshops of approximately twelve persons each.

Each workshop was addressed to discussions of curricula in a specific area: ecology and environmental science, environmental technologies, environmental management, and general education. Though each had a different focus, a high degree of similarity was exhibited in each of the workshop reports – thus leading to the conclusions at the end of these *Proceedings*.

Curricular Needs in Ecology and Environmental Sciences

Robert I. Bowman, Chairman
Richard C. Barbera, Recorder

Participants: Alexander, Brattstrom, Brittan, Cox, Fisher, Jameson, Kluss, Lowrie, Stocking, Szijj, Thomas, Winn

To provide a framework for its report, the workshop participants described the purpose of a college education as helping humans to know what it is to be human, and to learn to live with and be an harmonious part of our natural environment. The purpose of a college curriculum is to provide an opportunity to acquire knowledge and skills in a specific area of human endeavor.

From this, the group determined that the contemporary problems confronting us may be rather different from those of the future and which we cannot foresee; we must not, therefore, train specialists for today's problems. In other words, we should not try to match curricula in the liberal arts to a particular vocation. Our purpose in any undergraduate curriculum should be to turn out leaders who are versed in the following three areas of knowledge:

1. *The humanities.* Through exposure to ethics, esthetics, and other branches of philosophy, our students should develop intellectual discipline as well as refinements in judgment and taste. An exploration of human values relating to our moral ideals and goals, our motives of choice, and our patterns of good and bad conduct, provides us with a framework in which we can probe the basic question leading to moral disagreement among individuals and groups. Such values do not emerge from the study of the sciences. Whatever truths there are will be found in the humanities, and this will be so today and tomorrow, even though our values may change.

2. *The natural sciences and mathematics.* Through the sciences the student will acquire the specializations pertinent to an understanding of the interplay of forces between the physical and biological works of nature, of which man is but one part.

3. *The social sciences.* By focusing on man's life with other men in groups, we come to understand the economic, historical, political, sociological, criminological, psychological, legal and technological reasons for his actions.

Based on the above conceptions, the workshop panelists chose not to address their curriculum statements solely to the fields of biological ecology or environmental science, but rather to *ecology* in the broadest sense of the word and to *environmental studies*, not sciences. They agreed that there should be full interplay of the humanities, the natural sciences, and the social and behavioral sciences. The strengths of each of the State Colleges in these areas will, in large measure, determine what kind of curriculum will materialize.

Ecology potentially constitutes one of the most effective fields for introducing students to the nature of scientific inquiry, the workshop believed. Man has now begun to realize that growth of human population and technology has complicated his interrelationships with other organisms and his physical environment, rather than making him more independent of the natural world. Man has the capacity to produce worldwide change in the characteristics of his environment. Solutions to present and future problems of environmental quality and sustained use of resources requires both an ecological awareness by the public at large and an ecological technology far more advanced than anything existing today. Ecology thus demands an important position in the preprofessional curriculum for students in the natural sciences and in the liberal arts curriculum of all college students.

Inasmuch as there is a strong tendency for academicians to become somewhat segregated according to disciplines, there is clearly a need to determine to what extent an ecological or environmental point of view is presented in non-scientific disciplines, e.g., art, economics. It is possible that the undergraduate student is already being exposed to a broad spectrum of ecological problems through the eyes of varied non-scientist specialists. There is a need to know the extent of this emphasis to assemble complete lists of courses (and their descriptions) with emphasis in ecology and environment, and to identify faculty members with a strong commitment to the problems of the environment.

The participants agreed that the more students and faculty members specialize, the more they need to get together to solve group problems. The "give-and-take" response generated in these closely knit groups, where the problem-oriented approach is emphasized, prepares the participants for the realities of life. There is always a need for individual creative expression, but it takes a team approach to solve some of the enormous problems facing man today. For example, constitutional law could serve as a basis for the kinds of problems that could arise when a court injunction delays the construction of a proposed dam across a waterway. There are ecological, political, economic, technological, and ethical questions that need to be answered.

In the opinion of the group, among the many problems of the environment, two must be thoroughly understood and should constitute a major part of a basic environmental course. These are the problems of human population and pollution. The amount of waste that is generated today, for example in the United States of America, is a measure of our standard of living, and has little to do with the number of people. The study of pollution leads logically to technological problems and their economic bases.

Other conclusions of the workshop included:

1. Colleges should examine as many environmental programs as possible. Students are stimulating changes in courses and programs in all departments and in most institutions around the country.

2. Specific suggestions for an environmental curriculum for any one campus are inappropriate. There are many kinds of experiences possible, depending upon the students, faculty, and the campus community of each college. Any effort now to restrict experimentation would be academically unsound.

3. Specific course planning, extent of team approach, and feasibility of working at problem-solving projects in local environments, can only be handled at each campus. Whatever program results, however, will need to be nurtured, even if it leads to

self-destruction of the program. There is a need for continuing evaluation of the program by all participants.

4. Regulations governing the academic and administrative operations of the campuses should be liberalized, where necessary, to permit a free interplay of academic talents from as many disciplines as possible.

5. The success of the multidisciplinary approach to an environmental program will depend upon several factors. Clearly, they will be easier to initiate on younger campuses within the system. Historically, on some campuses, certain areas may have retained a close working arrangement so that joint participation in an environmental program today will be no major cause for concern.

6. Faculty must develop devices to better "use" the California State College system to promote their environmental programs. For example, instead of faculty from one campus having to go outside the system to up-date their knowledge of environmental problems, there should be instigated "in-house" symposia and summer institutes using State College expertise.

7. Finally, there ought to be a permanent "standing committee" on environmental curricula, composed of experts from the various State Colleges, to which a campus could turn for advice in founding its own new programs. The "Invitational Workshop on Curriculum Development in Ecology and Related Environmental Sciences" could serve as a basis for the establishment of such a committee.

Curricular Needs in Environmental Technologies

Donald W. Aitken, Chairman
Helen Fluhrer, Recorder

Participants: Barratt, Bockian, Flittner, Garman, Hauser, Maxwell, Montgomery, Shell, Simms, Trobitz

The Value of Diversity. The diversity of opinion represented on this panel reflects a diversity of approach that one can expect – indeed, should encourage – in meeting the curricular needs of new environmental technologies.

For example, on the one hand it was maintained by a participant that there will have to be a sacrifice in the classical training of the engineer in order to subsidize more opportunity for a broadened education in the social and physical impact of engineering technologies, while on the other hand another member of the group asserted that it is the theoretical role of a college to give the man the greatest depth in his technical specialty.

Similarly, one participant from industry supported the opinion that it is not the function of a college to turn out a product for industry, but rather it should be responsible for producing aware, educated people. The emphasis should be on job versatility, with less of a pointing in any one direction. But another industrial participant asserted that the student with the best specific technical training would still be at an advantage when he applies for a job.

The first type of view expressed in both of these paragraphs suggests a college program in which the requirements for specific technical accomplishment are reduced to make room for greater student time spent in related subject areas that can increase his understanding of ecological principles, environmental responsibility, and the potential for imaginative applications in new environmental technology. Obviously, though, there must be a parallel shift in hiring policies of industry to favor greater on-the-job training in a specific endeavor, in return for being able to hire scientists and engineers who are better equipped to comprehend social as well as technical complexities involved in decision-making affecting the application of technology.

The second type of view suggests less reliance on additional environmental courses outside of the technical discipline, and greater emphasis both on programs tailored specifically to meet particular environmental technologies (insofar as they are known and can be defined) and on the inclusion, within the structure of the "usual" technical courses, material on the environmental impact and application of that area of concentration.

Only time can tell if one of these classes of views is the better, or whether some sort of combination of these approaches will emerge. Unless there *is* a diversity of programs and opinions, though, there can be no such relative test.

As a result, this panel chose not to construct a specific "model" curriculum, but rather to identify certain fundamental curricular needs that should be recognized and implemented, regardless of the particular structure of the overall technical degree program.

Specific Suggestions

1. Engineering schools need to "take a hard look" at their programs, no matter how successful they may have seemed up to this point, at the very least with the aim of streamlining and consolidating approaches so that new concepts – including important cultural elements – may be built into the teaching of technical material. Further, technically-oriented departments should regularly review their programs in view of changing social emphases and student interest.

2. The future technologist needs to be able to study and comprehend changing values and ethics of modern society. This material can be offered as part of the engineering curriculum, but preferably in close association with departments in the humanities.

3. The future technologist, whether or not he chooses to direct his career toward an environmental application, should be required to take a course (or series) on "Man and His Environment," with this *not* taught by the engineering schools. A parallel – or more advanced – course might then originate in the engineering schools on "Man's Impact On His Environment," with this building upon the more basic ecological and social principles introduced in the earlier course.

4. Technological training must lead to an improvement in the understanding of the impact of that technology on the world. As such, considerations of the impact and other secondary consequences of the application of a technical specialty should be basic to the skill training itself. For example, the chemical engineer should acquire experience in toxicology, and the nuclear engineer should be required to study radiation biology. This can either be accomplished by cooperative arrangements with other campus departments, or engineering schools might hire biologists and other appropriate specialists.

5. To facilitate the acquisition of an appreciation for the impact of his technology upon the world, and for an understanding of the role of a certain technology in environmental science, engineering science requirements should favor the more immediately relevant applications, such as meteorology, hydrology, soil science, ecology, etc., in lieu of some of the more standard elementary science requirements. Toward this end, greater weight may be given elementary high school training in mathematics, physics, chemistry and biology.

6. To enable the extension of the future technologist's understanding into other relevant scientific and humanistic areas, *all* departments should review prerequisite requirements, so that fairly sophisticated concepts may be encountered without having to take a host of requirements. This also requires a shifting in emphasis in the early levels at least away from "hard" science to "soft" science, with the new emphasis aimed at communicating the field to other scientists not necessarily in that field. For example, the effect of mercury in the living cell *can* be introduced and discussed without the benefit of numerous "upstream" courses in biology and physiology.

7. Technical material in a specialty needs to be presented in a way that facilitates freer communication and information seeking outside of the field of competence or specialty. The environmental technologist must be able to ask questions in the languages of many

technologies, and to know where to go for answers that he can't arrive at himself. In parallel with freer communication, early emphasis needs to be placed on team research and group problem-solving as an extension of individual capabilities. Serious attention should be paid to Berkeley-type experiments in which multiple degrees can be awarded for members of a team working together on a single problem.

8. The student should be made aware that most of the environmental technology of the future has not yet been invented or discovered, and that the skills that he is learning are to provide him with interim tools. Imaginative approaches, rather than prescribed techniques, should be the rule, with a heavier emphasis on problem-solving right from the start. ("Here is an interesting problem. What do I need to know in order to be able to try and solve it? What should my curriculum be in order to give me these skills?") This could culminate in a "project semester" (or quarter) in which the student devotes his entire effort, on an individual study basis (although quite possibly as a member of an interdisciplinary team), toward a particular problem.

9. Serious attempts should be made to structure technical curricula for the new technologies, such as air pollution abatement and water pollution abatement, by adding these as new divisions carrying equal weight with the usual civil, chemical, electrical and mechanical engineering divisions.

10. As curricula aimed at the new environmental technologies are developed, a careful balance of all elements related to that technology must be maintained. For example, a program in noise pollution should encompass physical acoustics, acoustical engineering, physiological response to noise, and psychology (the latter as it relates to human perception and adaptation).

11. Whereas the complexity of the new environmental technologies is leading to numerous new fields, each college should *not* attempt to meet them all. The effort should be aimed at offering some very good programs, rather than many weak ones. On the other hand, the State College system *should* embrace within its nineteen campus system good programs in all of the important new technologies. Toward this end, students should perhaps be encouraged to move about within the system to encounter certain specialties.

12. There needs to be a closer working arrangement with industry in general, and environmental industry in particular (pollution abatement, etc.), to foster communication between industry and the college, and to allow the student to understand the nature and complexity of technology in order to motivate his own training. Internship programs with area industry (and carrying full academic credit) should be vigorously pursued, with support for this coming from the very pricing structure of the industrial commodities and services, as well as federal and state "incentive" payments or other subsidies.

13. As greater reliance is placed on elementary instruction in the basic sciences in high school, the State Colleges must recognize a new responsibility to assist in raising the level and quality of these high school programs, possibly including greater college faculty involvement as program developers and guest teachers in area high schools. Obviously, the educational merit of these kinds of supporting activities must be rated in a way that assigns adequate faculty compensation in proportion to the time spent in such involvement.

14. To prevent the community college transfer from being placed at a disadvantage, the four-year colleges must develop these new environmental programs in close communication and cooperation with the Community Colleges, with considerable cross-fertilization of ideas and people. This is particularly important in assuring the easy transition of a community college transfer into the third year of one of the new environmental technologies.

15. To keep the instructional material current with the state-of-the-art in environmental technology, maximum use should be made of outside specialists and experts in the field on a part-time basis, to teach particular subject areas, obviously with such semester-by-semester appointments not subject to arbitrary "freezes." Related to this is the need to provide the teachers in environmental science and engineering with adequate opportunity and stimulation to keep up with new ideas and practices through greater opportunity for faculty research and scholarship.

Curricular Needs in Environmental Management

Jimmy W. Hinkson, Chairman
Sally Loyd, Recorder

Participants: Bechtol, Hedrick, Kleintjes, Metzler, Straw, Teel, Turner, and Wylder

In approaching the question of curricular needs in environmental management, the workshop participants identified two general types of managers: managers within industry and government who require a broad understanding of the environmental problems and control, and those persons who are trained specifically in the management of the environment. The group limited its discussions of this latter type of manager, recognizing that many generalizations which apply to him will apply to the former; in addition, revisions in general education offerings could in many cases meet the needs of the first type.

In a consideration of the characteristics and training of the environmental manager, the participants pointed out that not only biological, but political, psychological, economic and anthropological concerns, as they relate to the environment, should be recognized. Most environmental problems are created by urban people and management of the environment therefore involves an understanding of value systems and life styles.

The workshop members concluded that specialists who can deal with specific problems of the environment are available, but that there is a need for people who are trained as problem-solvers – as *integrators* of information and specialization. The environmental manager should be sensitive to the problems of the environment and aware of the kinds of experts available who are knowledgeable in solving environmental problems. To request and then to evaluate the opinions of experts requires some in-depth training in science and technology. Further, the manager must be a planner – recognizing that some actions will create future problems. The manager must be alert not only to the costs of implementing environmental controls but to the methods – having an understanding of how to gain (effectively) political action.

These varied concerns should be reflected in a curriculum which is sufficiently flexible to allow the student to specialize in one area if so desired; however, the unknown future of potential job markets argues against programs which are in themselves narrowly directed. Regardless of specializations, each student should have training in three broad areas:

1. Values and Ethics
2. Science and Technology
3. Political Action

There is, moreover, a need for experience along with course work. At the present time, it is difficult to identify off-campus work experiences which would be closely related to the program. Instead, modern management techniques, such as the "team" approach to problem solving, as well as independent research, could be utilized.

In discussing the academic structure for such a program, the group concluded that existing academic structures should be retained. Many courses which would be useful to the environmental manager already exist, but are not shaped into a curriculum. Interdisciplinary arrangements are called for, but are difficult to arrange. Problems of promotion and tenure, which are accorded by individual departments, make professors hesitant to devote a portion of their time to interdepartmental programs. At the present time, there is little motivation for departmental cooperation in interdisciplinary efforts. On the other hand, if a separate "unit" is formed, it will probably evolve as yet another department. The current solution, then, is to utilize existing departments and disciplines with more flexibility than is now common. A structural system which will reward the professor will probably be the most successful. Thus departments could employ faculty members outside of the department's own discipline; motivations should be found for encouraging interdepartmental cooperation. Such interdepartmental cooperation may in the end be more effective than an overly-structured departmental program.

Curricular Needs in General Education

John R. Coash, Chairman
John J. Baird, Recorder

Participants: Cogswell, Haas, Hutcherson, Johnson, Lillard, Lincoln, Picker, Schafer, Stahl, Whitlock

The first conclusion of the workshop was that we cannot limit ourselves, in discussing genera education, only to *Title V** requirements, or to the 40 semester hours of course work, or only t the lower division because we run into all kinds of problems if we do this. These include th relationship of the community college transfers to our own freshmen and sophomores, and wha happens when they all get together later. For this and for other reasons, we concluded that genera education had to do with something broader than the 40-hour requirements or whatever it may tur out to be on the individual campus.

The participants came to a general agreement that some form of environmental studies shoul be included in the undergraduate education of all students. This, of course, simply supplement what you have heard from the previous three groups. The group, however, added a few things t this: There should not be a required course as such dealing with the environment in the genera education pattern. A required course, it was suggested, might well be self-defeating and furthermore, there would be a good deal of opposition from students and faculty to a specifi course requirement. This conclusion was reached with the realization that an understanding of th environment will come, if it hasn't already, to be considered in higher education circles of equa importance with the traditional requirements for a liberal education. The fact that we did no recommend a required course does not diminish our united feeling that all students should indee be involved and exposed to the subject matter of environmental studies as part of their genera education at the undergraduate level. This, then, requires that we do something about making sur that we offer courses which are of interest to the students and which include attention t environmental questions. They will be in various and sundry packages, and each campus and subjec area will do it differently.

The workshop group pointed out that certainly one of the alternatives to be considered is th integrated, interdisciplinary course which can be extended as far as one is able to find faculty willing to work together. Each student, no matter what his objective, should have the opportunity to pursue work in the environmental studies area one way or another.

Team teaching, to the group, seemed to be desirable no matter which kind of course wa proposed, though the question whether this really ends up being antidisciplinary o multidisciplinary is present.

Though not of direct relevance to the discussion here, the group was concerned with the majo in another area who decides at a fairly late stage in his career that he would like to become involved or gain background in environmental studies. This student may find himself considerably hampered

*Ed. note: California State College degree requirements are contained in *Title V, The California State Administrative Code.*

if there is a particular course, for example, in ecology he wants to take, but which requires prerequisites which he doesn't happen to have. So it was proposed that some sort of secondary option be made available which would give the student depth beyond a simplified explanation and which can provide people in various fields with subject matter which they can tie together with their own particular major area. This could, of course, include persons studying to become teachers. The group concluded that many of our own majors in the sciences were not generally educated in environmental studies; in fact, many graduates of science departments, including some of those departments that ought to be doing this sort of thing (particularly in biology and the earth sciences) have only a vague concept of the kinds of things that we are talking about today. All of this requires resources, and supports the conclusion that, given the current restrictions that we face, *there is need for the reallocation of priorities and funding on our campuses.* We need to establish a very convincing argument which will establish a favorable climate in which reallocation of priorities can indeed take place.

Finally, the general resources of the State College system itself might be considered. For example, the participants were interested in the notion of the traveling faculty. Also, particular sites for instruction in the environment might be used so that students could move from one to another.

It was also suggested that a central location be established for the distribution of information.

VII. CONCLUSION

In the course of the two-day meeting of some fifty participants, many ideas, concepts and proposals for action were put forth for discussion and examination. The workshop groups served to distill a number of conclusions and generalizations. At the risk of overlooking significant points, certain themes appeared early in the meeting's discussions and were given form in at least one of the workshop group reports. These themes are summarized below.

Model Curricula. No uniform, model curricula in ecology and related environmental sciences should be applied throughout the California State Colleges. Each college has the responsibility to assess its own strengths, its potential and the needs of its students as it develops new curricula or adapts existing courses and programs emphasizing environmental concerns. The experiences of colleges within the system and outside should, however, be noted; in this context, meetings such as the Invitational Workshop are most useful.

Specializations by College. Each college should seek to develop environmental studies focuses appropriate to its locale, student body, and resources. No college should seek to offer all possible approaches to the study of ecology. There should be complementary programs from one college to the next, rather than duplicatory ones. College planning and program development should take place with reference to other colleges in the system.

Articulation With Community Colleges. The majority of today's students in the State Colleges have begun their collegiate work in one of the state's many community colleges. Curriculum development in environmental studies must therefore provide for ease of transfer. Further, development of certain kinds of programs may require close cooperation with community colleges.

Cautious Development of Specialized Programs. A common theme throughout the course of the meeting was that the problems of the environment are so diverse, and the solutions so tentative, that training of large numbers of highly specialized persons is inappropriate. Students in the sciences, engineering, technology as well as the social sciences are best served by a substantial environmental component to their education to assist them in adapting to the demands of the future. Doubtless many persons in the years to come will play substantial roles, in their work careers and as members of the general public, in attempting to maintain and improve the environment. Such activities will be across a wide spectrum and will not be restricted to a limited number of occupational classifications. This suggests that in developing responses to the environmental problems, colleges should construct curriculum which can assist in the education of persons who can fulfill a number of different responsibilities.

Emphasis on the Environment Throughout Curriculum. Workshop participants agreed generally on the need for *all* students to engage in studies of the environment and its problems. All appropriate curricula should include attention to the study of the environment. Single-focus courses do not appear appropriate as a part of general education requirements; rather, a reshaping of courses and programs in a variety of disciplines is called for.

Interdisciplinary Studies. The education of students who are concerned with the problems of the environment and capable of contributing to their solutions cuts across many disciplines. The solutions to the problems of the environment, as reflected by workshop participants, will require not only scientific and technical skills, but political and economic expertise as well. The scientist or technologist who seeks a solution to a problem of the environment must understand the economic and political realities of the problem. The scientist in general, many participants pointed out, must realize the social and environmental impact new scientific and technical developments may have. The government leader and the industrial manager must be conversant with the scientific and technical knowledge of the environment and be aware of the kinds of specialists needed to attack environmental problems. Thus the need for interdisciplinary or multidisciplinary environmental studies was recognized by most participants; however, the problems of the collegiate, departmental structure were often noted as inhibiting the development of needed courses and programs.

Problem-Oriented Instruction. A common theme in discussions was the value of using a specific environmental problem upon which students and faculty can concentrate as a desirable pedagogical technique. Similarly, the need for work experience in an environmental problem area and individual or group research was stressed. While a problem-oriented curriculum and work experience are considered useful in many subject fields, their particular appropriateness in environmental studies was stressed.

Terminology. "Ecology," "environment," "ecological studies," and "environmental studies" and "sciences" are among the various terms applied to academic programs concerned with aspects of the environment. Based on workshop discussions and the existing literature concerning academic programs in the general subject area, the term "environmental studies" appears most useful as a general terminology broadly applicable to a variety of programs. "Ecology" as a term for academic degrees and programs is most generally understood as applying to the science of ecology within the biological sciences. Environmental science and environmental technology have their appropriate usages but do not clearly connote specific degree or other academic programs.